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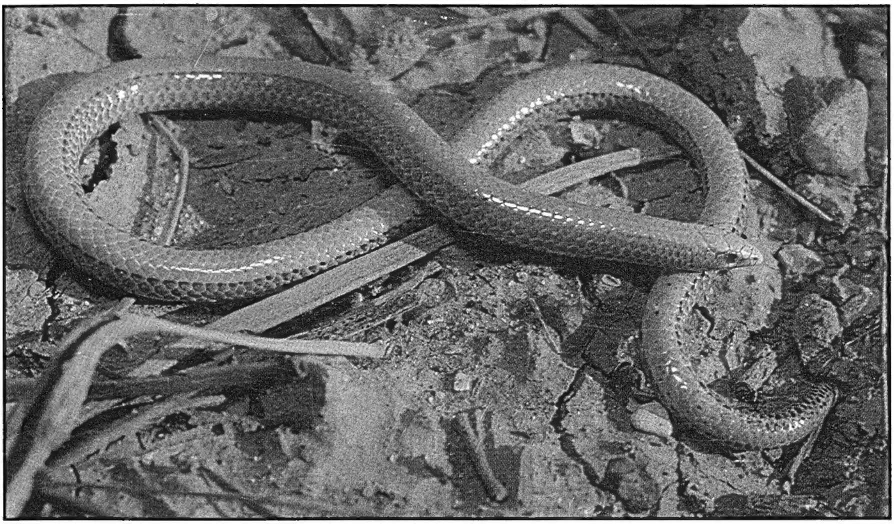

Bronzeback Legless Lizard *(Ophidiocephalus taeniatus)* 6km SW of Gypsum Bore approximately 70km W of Oodnadatta. See paper on page 11. (photo: M. Hutchinson).

A Giant Banjo frog *(Limnodynastes interioris)* from Pomingalarna, Wagga Wagga. See paper on page 7. (photo: M. Murphy).

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HERPETOLOGICAL NOTES

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THE BREEDING OF GILLEN'S PYGMY MONITOR *VARANUS GILLENI*, LUCAS & FROST 1895.

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INTRODUCTION

Varanus gilleni is a small arboreal monitor from arid Australia. The distribution of this species ranges from northern SA, the desert areas of NT, and the interior of WA up to the north-west coast (Bustard 1970, Cogger 1959, 1992, Ehmann 1992, Gow 1981, Hoser 1989, Houston 1973, 1976, Keast 1959, Mertens 1942, 1958, Pianka 1969, 1982, 1986, Storr 1980, Storr et al 1983, Swanson 1976, Wilson & Knowles 1988, Worrell 1966). This species is strictly adapted to arboreal life, which can be seen in the morphology of the tail (Bedford & Christian 1996). The tail is flat at the base, round in the middle, and the texture is coarse. The scales on the lower surface have small spiny tips to support the animals while resting. Usually *V.gilleni* is found under loose bark or in cracks of mulga, gum or desert oak trees. One specimen had been observed on the top of a termite mound near Alice Springs. Although the distribution extends over a large area, there are no subspecies known, and the pattern is very similar throughout the whole range. The ground colour on the back is light brown to grey with dark, sometimes purple, spots forming bands across the back in some individuals.

Reproduction of this small monitor in captivity has been reported several times (Boyle & Lamoreaux 1983, Card 1994, Eidenmüller 1994, Gow 1982, Horn 1978). Horn & Visser (1989) gave an overview of all captive breeding of monitors worldwide, including *V.gilleni*; James et al (1992) gave an overview of the Australian species.

In this paper the breeding of *V.gilleni* over several years, and into the second generation is reported.

Housing

One pair of monitors is housed together in an enclosure measuring 50 x 60 x 60 cm. The terrarium is made of glass, with sliding doors at the front. Both sides and the back are covered with cork-bark to give the animals appropriate climbing surfaces. Sand is used as ground cover and a small dish with fresh water is permanently offered. Some rough branches and a hiding box, measuring 25 x 20 x 15 cm, complete the setting. Illumination is provided by one 50W mercury lamp and the air is heated by a 75W spotlight, which is installed over one branch, to provide a hot spot for basking. No extra UV and no seasonal variation of daylength is offered to the animals. They are active year round with no resting period.

Another enclosure, measuring 90 x 40 x 50 cm, was used for the offspring. It was illuminated with a 16W tube, and heating was provided by a 40W spotlight. The other facilities were similar to the above mentioned enclosure.

Feeding

In the wild *Varanus gilleni* mostly feeds on insects, such as crickets, cockroaches, and spiders, which it hunts under the bark of trees (James et al 1992, Losos & Greene 1988, Pianka 1986). We feed the monitors twice a week with crickets, grasshoppers, and cockroaches, which are always dusted with a vitamin-mineral powder (Korvimin ZVT®). From time to time larvae of the giant mealworm (Zophobas morio) are offered.

Reproduction

As mentioned above, one pair of *Varanus gilleni* was housed together all year round. The

Table 1: Hatchling data of *varanus gilleni*

Clutch No.	Copulation	Egg Deposition	Eggs (n)	Incubation Period (days)	Hatchlings (n)	Mean SVL (cm) x	Range of Variation Sx	Mean TL (cm) x	Range of Variation S x
1	1.1 - 3.1.93	30.1.93	2	124 - 131	2	6.5	0	7.5	0.07
2		7.4.93	2	101 - 111	2	6.3	0.14	7.7	0.07
3		23.6.95	3	106 - 112	3	6.3	0.06	7.7	0.36

Clutch No.	Mean Ratio SVL:TL x	Range of Variation Sx	Mean Weight (g) x	Range of Variation Sx
1	1.15	0.01	3.4	0.21
2	1.21	0.04	3.1	0.07
3	1.22	0.06	3.4	0.06

male was a very old animal, assumed to have been over 15 years old when he was bought in 1985. The female was slightly younger. As no courtship could be observed, we took the opportunity to change the male with another one, which probably was younger, in 1991. Because of the bad condition of the new male, who only had one claw on each of his front legs, we kept the pair together in a lower enclosure, to give him the chance of copulation.

After a few days the male showed interest in the female. He followed her, flicking nervously with his tongue and waving his head. At first the female tried to escape, but after a while the male was able to mount the female and start to copulate. Because of the big size difference, the copulation was different from that described by Murphy & Mitchell (1974). Multiple copulations during the 1992 mating period were observed, but no fertile eggs were produced. In 1993 between 1 and 3 January several copulations occurred, and by the end of January the body volume of the female increased. We removed the male from the enclosure to give the female the opportunity to lay eggs without stress. On 30 January she deposited 2 eggs in the egg-laying box. We removed them and incubated them half buried in a plastic container, filled with damp vermiculite (1 part substrate and 2 parts water by weight). The incubation temperature was between 26° and 29°C.

Four weeks later we reintroduced the male into the enclosure of the female. Though no further matings were observed. The female again laid two eggs in the egg-laying box on 7 April, obviously without being stressed by the male. These eggs were incubated in the same manner as the earlier clutch.

Unfortunately the female did not start feeding again after depositing the second clutch, and died five days later.

All eggs were fertile, which could be easily determined by the increase in the egg-volume and the development of blood vessels inside. Considering our own experience in breeding small species of monitor lizards (Eidenmüller 1986, 1989, 1994, Eidenmüller & Horn 1985, Eidenmüller & Wicker 1991, Wicker 1993) and the data published by other breeders (Bartlett 1981, 1982, Flugi 1990, Gow 1982, Horn 1978) we estimated that the incubation period should be around 100 to 120 days.

The babies from the first clutch hatched after 124 and 131 days, those from the second clutch after 101 and 111 days of incubation. The difference in the incubation period between these two clutches is not yet understood. Probably high outside temperatures had an influence on the earlier hatching of the monitors of the second clutch, as in June 1993 the temperatures went up into the high 30s C. Hatching data for all the offspring are listed in Table 1.

Different care of the babies is not required. In the beginning the offspring of both clutches were kept together in an enclosure, measuring 60 x 30 x 30 cm. The setting was similar to the enclosure of the adults. They were fed three to four times a week with small crickets, dusted with a vitamin-mineral powder (Korvimin ZVT®). With this diet the young monitors developed well.

In 1995, exactly 2 years after hatching, one of the babies proved to be a female and was put together with the adult male. We used again the lower enclosure, to give the old male the opportunity to copulate with the young female. Just after introducing him to the female, he started head waving and tried to mount her. The same series of behaviour happened as described above. Though copulations could not be observed she deposited three eggs in the egg-laying box on 23 June 1995. We incubated them as mentioned above. After 106 days two babies hatched, the third after 112 days. The hatching data of these offspring are also listed in Table 1.

SUMMARY

Varanus gilleni is an easy monitor lizard to keep, and does not need too much space. The pairs we had could be housed together all year round. No hibernation was essential, but a separation of the adults could be helpful in inducing reproduction. Matings can be observed during the whole year. The eggs were successfully incubated in vermiculite with substrate-to-water ratio of 1:2 (by weight). Females are fertile at the age of two years.

LITERATURE CITED

Bartlett, R.D. (1981). Note on captive reproduction of Storr's Monitor, *Varanus storri*. Bull. Chicago Herpet. Soc. 16(3):65-66.

Bartlett, R.D. (1982). Initial observations on the Captive Reproduction of *Varanus storri*. Mertens. Herpetofauna 13(2):6-7.

Bedford, G.S. & Christian, K.A. (1996). Tail morphology related to habitat of varanid lizards and some other reptiles. Amphibia-Reptilia 17:131-140.

Boyle, D.M. & Lamoreaux, W.E. (1983). Captive reproduction in the Pygmy Mulga Monitor, *Varanus gilleni*, at the Dallas Zoo. Proc. Rept. Symp. Capt. Husbandry 7:59-63.

Bustard, H.R. (1970). Australian reptiles. Collins, Sydney, London. 162 p.

Card, W. (1994). A Reproductive History of Monitors at the Dallas Zoo. The Vivarium 6(1):26-29,44.

Cogger, H.G. (1959). Australian Goannas. Aust. Mus. Mag. (Nat. Hist.) 13(3):71-75.

Cogger, H.G. (1992). Reptiles and Amphibians of Australia. New Edition. Reed Pty Ltd Revised, Sydney 775 p.

Ehmann, H. (1992). Encyclopedia of Australian Animals - Reptiles. Angus & Robertson Pub. Pty Ltd, Sydney, 495 p.

Eidenmüller, B. (1986). Beobachtungen bei der Pflege und Nachzucht von Varanus (Odatria) *t.timorensis* (Gray, 1831). Salamandra 22(2/3):157-161.

Eidenmüller, B. (1989). Beobachtungen bei der Haltung und Nachzucht von Varanus (Odatria) *tristis orientalis* (Fry, 1913). Salamandra 25(3/4):265-271.

Eidenmüller, B. (1994). Bemerkungen zur Haltung und Zucht von Varanus acanthurus (Boulenger, 1885) *V.storri* (Mertens, 1966) under *V.gilleni* (Lucas & Frost, 1895). Herpetofauna 16(88):6-12.

Eidenmüller, B. & Horn, H.-G. (1985). Eigene Nachzuchten und der gegenwartige Stand der Nachzucht von *Varanus (Odatria) storri* (Mertens, 1966). Salamandra 21(1):55-61.

Eidenmüller, B. & Wicker, R. (1991). Einige Beobachtungen bei der Pflege und Nachzucht von *Varanus (Odatria) timorensis similis* (Mertens, 1958). Salamandra 27(3):187-193.

Flugi, U. (1990). Bericht uber die Haltung

und Nachzucht des Storr'schen Zwergwarans *Varanus storri* (Mertens, 1966). *Herpetofauna* 12(67):31-34.

Gow, G. (1981). Checklist of the Reptiles and Amphibians of the N.T. Nat. 4: 14-19.

Gow, G. (1982). Notes on the reproductive biology of the Pygmy Mulga Goanna *Varanus gilleni* (Lucas & Frost, 1895). N.T. N.T. Nat. 5:2-4.

Horn, H.-G. (1978). Nachzucht von *Varanus gilleni*. Salamandra 14(1):29-32.

Horn, H.-G. & Visser, G.J. (1989). Review of reproduction of Monitor Lizards *Varanus* ssp. in captivity. Int. Zoo. Yb. 28:14-150.

Hoser, R.T. (1989). Australian Reptiles & Frogs. Pierson & Co., Mosman, Sydney NSW, 238 p.

Houston, T.F. (1973). Reptiles of South Australia: A Brief Synopsis. Extract from "South Australian Year Book, 1973".

Houston, T.F. (1976). Dragon Lizards & Goannas of South Australia. South. Aust. Mus. Adelaide 84p

James, C.D., Losos, J.B. & King, D.R. (1992). Reproductive Biology and Diets of Goannas (*Reptilia: Varanidae*) from Australia. J.Herpetol. 26(2):128-136.

Keast, A. (1959). The Reptiles of Australia. Monograph. Biol. 8: 115-135.

Losos, J.B. & Greene, H.W. (1988). Ecological and evolutionary implications of diet in monitor lizards. Biol. J. Linn. Soc. 35:379-407.

Mertens, R. (1942). Die Familie der Warane. Dritter Teil: Taxonomie. Abh. senckenberg. naturf. Ges. 466:235-391.

Mertens, R. (1958). Bemerkungen uber die Warane Australiens. Senck. biol. 39(5/6):229-264.

Murphy, J.B. & Mitchell, L.A. (1974). Ritualised combat behaviour of the Pygmy Mulga Monitor Lizard, *Varanus gilleni*. Herpetologica 30:90-97.

Pianka, E.R. (1969). Notes on the Biology of Varanus caudolineatus and *Varanus gilleni*. W.Aust.Nat. 11:76-82.

Pianka, E.R. (1982). Observations on the Ecology of Varanus in the Great Victoria Desert. W.Aust.Nat. 15(2):1-8.

Pianka, E.R. (1986). Ecology and Natural History of Desert Lizards. Princeton Univ. Press, Princeton, New Jersey, 208 p.

Sprackland, R.G. (1989). Mating and Waiting: A Status Report on Reproduction in Captive Monitor Lizards. Proc. Northern Cal. Herpet. Soc. 4:47-54.

Storr, G.M. (1980). The Monitor Lizards of Western Australia. Rec.W.Aust.Mus. 8(2):237-293.

Storr, G.M., Smith, L.A. & Johnstone, R.E. (1983). Lizards of Western Australia II: Dragons and Monitors. W.Aust.Mus.Perth, 113 p.

Swanson, S. (1976). Lizards of Australia. Angus & Robertson Revised & Expanded 1987, Sydney, 160 p.

Wicker, R. (1993). Pflege und Zucht von Varanus acanthurus. Monitor 2(1):13-14.

Wilson, S.K. & Knowles, D.G. (1988). Australia's Reptiles. William Collins Pty Ltd. 447 p.

Worrell, W. (1966). Reptiles of Australia. Angus & Robertson Ltd, Sydney, London, Melbourne, 207 p.

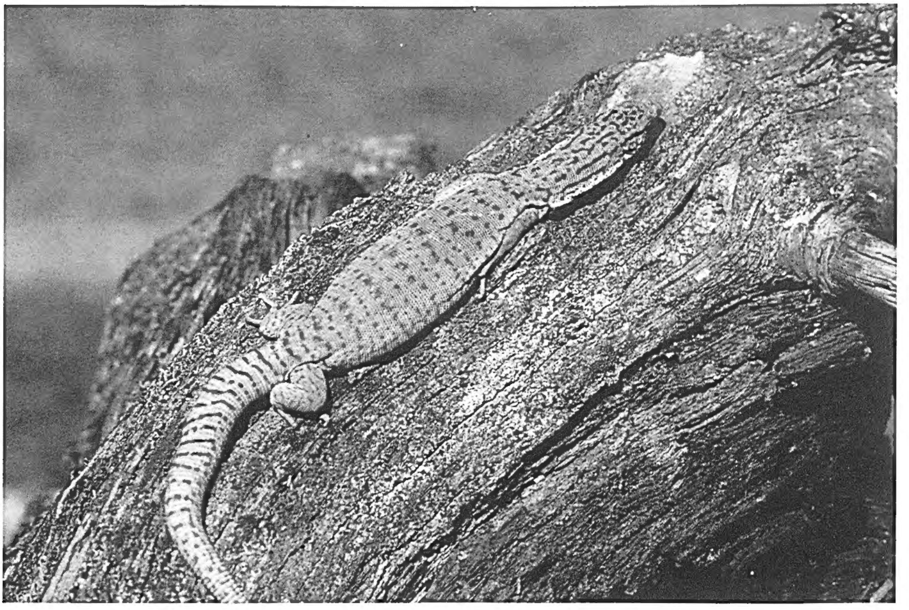

Figure 1 Adult Male *V. gilleni* bred in captivity

Figure 2 Neonate *V. gilleni* emerging from the egg

FROGS AT WAGGA WAGGA, NSW
A COMPARISON OF RECENT AND HISTORICAL RECORDS

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INTRODUCTION

The Wagga Wagga area, on the south-west slopes of southern New South Wales, has been subjected to extensive habitat changes since European settlement in 1832. Most of the original vegetation has been cleared, and the area is now predominantly devoted to agriculture. The impact of this widespread habitat alteration on the species composition of frogs in the area has not been assessed.

This paper presents the results of frog surveys undertaken between 1992 and 1996 at two sites at Wagga Wagga, and compares them with museum and historical records for the area. The oldest records are those of Fletcher (1890), which provide a long-term perspective of the changes in the regional diversity of frogs.

STUDY SITES

The two study sites were Pomingalarna Reserve (35°07'S, 147°18'E) (Fig. 1) and Wollundry Lagoon Reserve (35°07'S, 147°22'E) (Fig. 2). Pomingalarna is an undulating woodland area dominated by Western Grey Box *Eucalyptus microcarpa*, Blakeley's Red Gum *Eucalyptus blakelyi* and White Cypress Pine *Callitris glaucophylla*. A farm dam and an abandoned quarry provide small areas of aquatic habitat. Wollundry Lagoon is a permanent billabong of the Murrumbidgee River, bordered by River Red Gums *Eucalyptus camaldulensis* and the introduced Weeping Willow *Salix babylonica*.

METHODS

Observations of the frog species occurring at the two sites were collated from 12 visits to the Wagga Wagga area between 1992 and 1996. The timing of visits was opportunistic, and included occasions during and after rain as well as during dry periods.

Survey methods included identification and location of calling frogs, random spotlighting around water bodies to locate non-calling frogs, and searches by day for inactive frogs. Frogs were captured, identified using the keys and descriptions in Robinson (1991) or Cogger (1992), and released. Voucher specimens were taken of frogs of uncertain identity and were lodged with the Australian Museum.

A search was undertaken in the Australian Museum and the CSIRO Australian National Wildlife Collection for frog records from the Wagga Wagga area (here defined as 35°00'S to 35°15'S and 147°00'E to 147°50'E). The herpetofaunal records of Fletcher (1890) and Caughley and Gall (1985) were also examined, and all frog records for the Wagga Wagga area retrieved.

RESULTS

A total of six frog species (one hylid and five myobatrachids) were recorded between 1992 and 1996 at the two study sites. Five species were recorded at Pomingalarna, and three species were recorded at Wollundry Lagoon (Table 1).

A total of six frog species (two hylids and four myobatrachids) from the Wagga Wagga area were represented in the collections of the CSIRO and the Australian Museum (Table 2). One species was additional to those recorded at Pomingalarna and Wollundry Lagoon during the present survey: the Southern Bell Frog *Litoria raniformis*. Undetermined specimens of *Crinia* in the Australian Museum (collected by Caughley and Gall (1985) and described as either the Plains Froglet *Crinia parinsignifera* or Common Froglet *Crinia signifera*) may also be additional to the present survey.

Table 1
Frog Species Found at the Study Sites

Pomingalarna	Peron's Tree Frog *Litoria peronii* Plains Froglet *Crinia parinsignifera*[1] Giant Banjo Frog *Limnodynastes interioris* Spotted Marsh Frog *Limnodynastes tasmaniensis* Common Spadefoot Toad *Neobatrachus sudelli*
Wollundry Lagoon	Peron's Tree Frog *Litoria peronii* Barking Marsh Frog *Limnodynastes fletcheri* Spotted Marsh Frog *Limnodynastes tasmaniensis*

Table 2
Frog Specimens from Wagga Wagga in Museum Collections

CSIRO Collection		Museum Catalogue No.
Litoria peronii	1 specimen	A0479
Litoria raniformis	7 specimens	A0480-82 & A0488-91
Limnodynastes interioris	1 specimen	A0635
Australian Museum		
Crinia sp.[2]	3 specimens	R92145-47
Limnodynastes interioris	4 specimens	R78896 & R37399-401
Limnodynastes tasmaniensis	4 specimens	R15132, R51324-5 & R114564
Neobatrachus sudelli	1 specimen	R51326

Fletcher (1890) recorded four frog species at Wagga Wagga in September and October 1889: *Litoria peronii, Litoria raniformis, Crinia signifera and Limnodynastes tasmaniensis.* A fifth species was also calling but could not be captured for identification. Caughley and Gall (1985) recorded five species at Wagga Wagga: *Litoria peronii, Litoria raniformis,* an undetermined species of *Crinia* (as noted above), *Limnodynastes interioris* and *Limnodynastes tasmaniensis.*

HABITAT AND BEHAVIOURAL DATA (PRESENT SURVEY)

The following brief notes summarise the habitat and behavioural data recorded at the two study sites between 1992 and 1996.

Litoria peronii was commonly recorded calling at night during the spring and summer months from positions in trees, saplings and shrubs close to or overhanging water. Frogs called most frequently following rain, but also occasionally during dry periods. One frog was

1 The identity of this species was uncertain. Four voucher specimens were lodged with the Australian Museum (R146617-19 & R147000).

2 Specimens remain undetermined but are listed in the Museum database by default as *Crinia signifera* (Sadlier pers. comm. 1996)

found in August, sheltering by day beneath a rock.

Crinia parinsignifera was recorded in all seasons, and at Pomingalarna was the commonest and most frequently recorded species. Frogs called at night, and sometimes by day, from concealed locations close to water, and were found by day sheltering beneath rocks near water.

Limnodynastes fletcheri was recorded calling from burrows and concealed locations on the water's edge at Wollundry Lagoon at night in November following heavy rain. Floating spawn was observed the next morning.

Limnodynastes interioris was recorded calling at night in September from concealed locations in long grass bordering the dam at Pomingalarna. The dam was at full capacity indicating recent rainfall.

Limnodynastes tasmaniensis was recorded calling by day and night in all seasons and weather conditions from burrows or concealed in grass at the water's edge. Frogs were occasionally found by day sheltering under debris distant from water. Frogs belonged to the northern call race described by Littlejohn and Roberts (1975), and included animals both with and without a vertebral stripe.

Neobatrachus sudelli was recorded calling at night in August, floating in shallow ephemeral pools formed after heavy rain.

DISCUSSION

Despite the widespread loss of native vegetation around Wagga Wagga, it appears that the frog diversity has not changed greatly in the last century. Some species, such as *Litoria peronii* and *Limnodynastes tasmaniensis*, have remained common since Fletcher's time. One species, *Litoria raniformis*, may have become locally extinct.

The present study was able to detect a number of burrowing frog species when survey times coincided with favourable weather conditions. Such opportunities may not have been available to Fletcher, and so it is probably not surprising that these species were absent from his earlier collection. Fletcher (1892) commented that burrowing frog species were probably under-represented in many of his collections.

The absence of *Litoria raniformis* from the current survey is significant. The species has declined markedly in southern inland New South Wales (Osborne 1990; Ayers 1995), and is listed as endangered in the *NSW Threatened Species Conservation Act 1995*. It may be extinct in the Wagga Wagga area. The most recent records of this species in the area are February 1976 (CSIRO collection) and December 1979 (Caughley and Gall 1985). This corresponds with the timing of the species' disappearance from the Southern Tablelands of New South Wales (Osborne 1990).

Most of the frog species expected for the Wagga Wagga area were identified in the present study. A total of 17 species were documented in the south-west slopes region by Caughley and Gall (1985). Of these, seven species are restricted to the eastern highlands and do not occur within the Wagga Wagga area, and one occurs on the western plains and is also outside of the Wagga Wagga area.

The identity of the species of *Crinia* recorded in the present survey, and by Caughley and Gall (1985), were not determined with certainty. Further study is needed to confirm which species occur in the Wagga Wagga area. Based on consideration of published distributions (Robinson 1991; Cogger 1992; Barker, Grigg and Tyler 1995), it is possible that *Crinia parinsignifera, Crinia signifera* and Sloane's Froglet *Crinia sloanei* all occur there.

An additional species, the Broad-palmed Frog *Litoria latopalmata*, is currently extending its range into southern inland New South Wales (Rauhala and Osborne 1994; Lemckert *et al.* 1995). This species could potentially be recorded in the Wagga Wagga area at a future date.

This study did not provide quantitative data for the relative abundance of each species of frog in the Wagga Wagga area, or information

about the amount of remaining useable habitat for each species. This information should be the focus of future frog surveys in the region.

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REFERENCES

Ayers, D., (1995). Endangered fauna of western New South Wales. NSW National Parks and Wildlife Service, Hurstville, NSW. 274 pp.

Barker, J., Grigg, G.C. and Tyler, M.J., (1995). A field guide to Australian frogs. Surrey Beatty & Sons, Chipping Norton. 407 pp.

Caughley, J. and Gall, B., (1985). Relevance of zoogeographical transition to conservation of fauna: amphibians and reptiles of the south-western slopes of New South Wales. Australian Zoologist 21(6): 513-527.

Cogger, H.G., (1992). Reptiles and amphibians of Australia (5th edition). Reed Books, Chatswood, NSW. 775 pp.

Fletcher, J.J., (1890). Contributions to a more exact knowledge of the geographic distribution of Australian Batrachia. No. I. Proc. Lin. Soc. NSW, ser. 2, 5: 667-76.

Fletcher, J.J., (1892). Contributions to a more exact knowledge of the geographic distribution of Australian Batrachia. No. III. Proc. Linn. Soc. NSW, ser. 2, 7: 7-19.

Lemckert, F., Law, B., Anderson, J. and Chidel, M., (1995). A further range extension of the broad-palmed frog *Litoria latopalmata*. Herpetofauna 25(2): 12-13.

Littlejohn, M.J. and Roberts, J.D., (1975). Acoustic analysis of an intergrade zone between two call races of the *Limnodynastes tasmaniensis* complex (Anura: Leptodactylidae) in south-eastern Australia. Australian Journal of Zoology 23: 113-122.

Osborne, W., (1990). Declining frog populations and extinctions in the Canberra region. Bogong 11(4): 4-7.

Rauhala, M.A. and Osborne, W.S., (1994). Recent records of the broad-palmed frog *Litoria latopalmata* in the ACT. A southerly extension of the known range of the species in south-eastern Australia. Herpetofauna 24(1): 39-41.

Robinson, M., (1991). Frog Watch Field Guide (1st edition). Australian Museum, Sydney. 91pp.

Figure 1: Dam at Pomingalarna. Habitat of *Litoria peronii, Crinia parinsignifera, Limnodynastes interioris* and *Limnodynastes tasmaniensis*.
Photo by Pam Rawle

Figure 2: Wollundry Lagoon. Habitat of *Litoria peronii, Limnodynastes fletcheri* and *Limnodynastes tasmaniensis*.
Photo by Michael Murphy

NEW INSIGHTS INTO THE DISTRIBUTION AND HABITAT OF THE VULNERABLE BRONZEBACK LEGLESS LIZARD *OPHIDIOCEPHALUS TAENIATUS*

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Until recently, the Bronzeback Legless Lizard, *Ophidiocephalus taeniatus* was known only from the type specimen collected at Charlotte Waters in the southern Northern Territory in 1897 (see Lucas & Frost 1897). In 1978 it was rediscovered near Abminga in South Australia (Ehmann & Metcalfe 1978), and two specimens were found at sites near Coober Pedy in the mid 1980's (Cogger et al. 1993). Since 1986, no *O. taeniatus* have been found despite several surveys in the far north of South Australia (Ehmann 1992; Hutchinson 1994). The Reptile Action Plan (Cogger et al. 1993) categorises *O. taeniatus* as 'Vulnerable' on the basis of its very limited distribution and paucity of records. Moreover, several authors (Wilson & Knowles 1988 and references within) claim that *O. taeniatus* is potentially endangered due to the effects of cattle on its apparently narrow microhabitat requirements.

During September 1994 and 1995, the Exploring Society (ANZSES) conducted a biological survey throughout the Arckaringa Region located in the remote dry northern region of South Australia (27° 49'S, 134° 46'E). This article reports the discovery of six *O. taeniatus* at four previously unsurveyed sites near Arckaringa (Fig. 1). These are very significant animals because they represent the first sighting of this species for eight years, and are from a new locality which is distant from, but between, Abminga and Coober Pedy. This suggests that *O. taeniatus* may be distributed across a relatively broad area in northern South Australia.

Five of the animals were found by raking underneath mature Gidgee, *Acacia cambagei* along a dry sandy watercourse which cut through stony gibber plains. The *O. taeniatus* at Coober Pedy, Abminga and Charlotte Waters were also collected from dry creek beds that were structurally similar to those at Arckaringa and bordered by *A. cambagei* (Ehmann 1981; Hutchinson 1994). Each animal was found under a different tree, in loose soil blanketed by a deep undisturbed leaf litter. Thus, our data add to those which suggest that *O. taeniatus* prefer the vicinity of channels that cut through stony plains, and inhabit areas with a dense litter of leaves.

The sixth animal however, was collected by hand from atypical habitat underneath a Mulga, *A. aneura* on an open rocky plain some 8 kilometres from the nearest major watercourse. The *A. aneura* was close to a small, dry, braided waterway, and the animal may have been distributed to this locality during a period of heavy water flow. As is typical, the leaf litter under the *A. aneura* was sparse and very much thinner than that under the *A. cambagei*. The *A. aneura* formed part of a diffuse Mulga shrubland. These data are the first to suggest that *O. taeniatus* can inhabit areas lacking dense litter in locations some distance from major water channels.

We raked approximately 20 litter mats to obtain the 6 animals: 18 under *A. cambagei* and 2 under *A. aneura*. Further raking under 5 of the trees from which *O. taeniatus* was found (including the *A. aneura*) failed to uncover fur-

ther animals. This is interesting because densities of *O. taeniatus* at Abminga were apparently high with multiple animals being recorded in close proximity (Ehmann 1981). No other reptiles were found under the *A. aneura*, however *Lerista desertorum*, *L. muelleri*, *Menetia greyii* and *Delma australis* also inhabited the leaf litter underneath the *A. cambagei*.

Interestingly, the three animals captured in 1995 were all collected on the same day after substantial rain during the previous night. The air temperature ranged from 8° C overnight to 24° C (in the shade) the following day, which was humid and sunny. One animal was discovered late in the morning, two were found early in the afternoon, and all occupied litter that was shaded from the sun. Considerable raking in similar habitats on dry, humid, sunny days before and after this period failed to uncover *O. taeniatus* suggesting that this species may have been induced to come into the surface litter by the rain.

As part of the larger survey in 1995, several lines of 6 pitfall traps (60 cm depth x 12.5 cm diameter) connected by 50 m of drift fence were positioned nearby to the areas from which *O. taeniatus* were found. The traps were open for 4 days and nights but failed to trap *O. taeniatus*. Similarly, during both years of the study, comparable pit-lines scattered in suitable habitats throughout the Arckaringa region failed to capture this species. The *O. taeniatus* discovered prior to this study were also captured by hand indicating that raking and subsequent capture is the most effective collection technique for this legless lizard.

The discovery of *O. taeniatus* at sites throughout the Arckaringa region of northern South Australia suggests that this species may be more widespread in the area between Abminga and Coober Pedy than previously thought. Our data also indicate that *O. taeniatus* can utilise habitats other than the typical wide sandy channels and dense litter of *A. cambagei* leaves from which they have been recorded. Together, these data highlight previously unknown habitat conditions and localities that are likely to support *O. taeniatus*, and provide encouragement for the future survival of this species.

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REFERENCES

Cogger, H., Cameron, E. E., Sadlier, R. A. & Eggler, P. (1993). The Action Plan for Australian Reptiles. Australian Nature Conservation Agency Endangered Species Program, Project Number 124.

Ehmann, H. & Metcalfe, D. (1978). The Rediscovery of *Ophidiocephalus taeniatus* Lucas and Frost (*Pygopodidae, Lacertilia*) the Bronzeback. Herpetofauna 9(2), 8-10.

Ehmann, H. (1981). The natural history and conservation of the bronzeback (*Ophidiocephalus taeniatus* Lucas and Frost) (*Lacertilia, Pygopodidae*). In C. B. Banks and A. A. Martin (Eds.) Proceedings of the Melbourne Herpetological Symposium, 1980. pp. 7-13. Zoological Board of Victoria, Melbourne.

Ehmann, H. (1992). The apparent severe decline of the Bronzeback Legless Lizard (*Ophidiocephalus taeniatus*) at Abminga. Herpetofauna 22(1), 31-33.

Hutchinson, M. (1994). Raking up a party. South Australian Herpetology Group Newsletter 87.

Lucas, A. H. S. & Frost, C. (1897). Description of two new species of lizards from Central Australia. Proceedings of the Royal Society of Victoria 9, 54-56.

Wilson, S. K. & Knowles, D. G. (1988). Australia's Reptiles: A Photographic Reference to the Terrestrial Reptiles of Australia. Collins, Sydney.

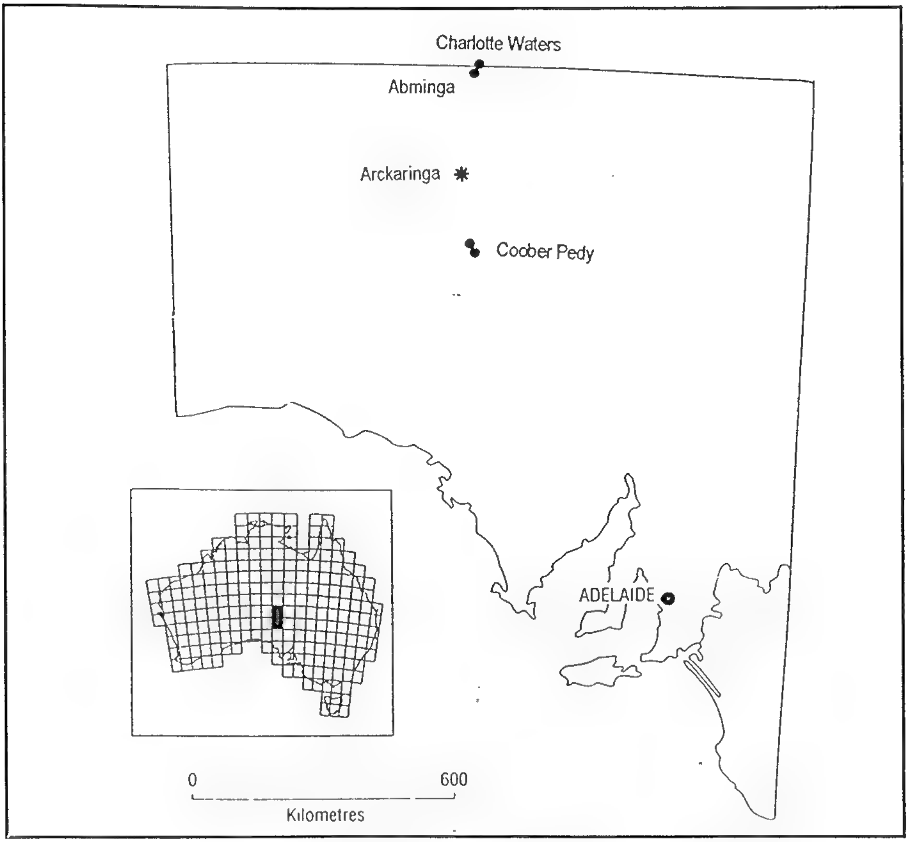

Figure 1. The previous distribution of *Ophidiocephalus taeniatus* (•) and the site of those recorded during the survey (*). Six animals were found at Arckaringa, and five were collected as specimens and lodged with the South Australian Museum (27° 40'S, 134° 40'E: R44653, R44668, the third animal was released; 27° 44'S, 134° 49'E: R46244; 27° 41'S, 134° 50'E: R46175; 27° 47'S, 134° 47'E: R46224).

CAPTIVE REPRODUCTION AND LONGEVITY IN THE EASTERN WATER DRAGON (*PHYSIGNATHUS LESUEURII*).

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ABSTRACT

Eastern water dragons are large and long lived agamid lizards that are easy to keep and breed in captivity. We report lifetime reproduction in a captive female over 23 breeding seasons. This female typically laid two clutches of eggs each year, the first in early November and the second in mid December. More eggs were usually laid in the first clutch each year, and these eggs were also heavier than eggs in the second clutch. Age at maturity, nesting behaviour, nest site defence and evidence for within-season sperm storage are described for this single female lizard. We suggest that 25 to 28 years of age is the maximum lifespan for this species in captivity.

INTRODUCTION

In November 1967 two 12 year old boys captured an adult male water dragon (SVL 210 mm) at Carroll Creek in the Sydney suburb of Forestville. It was blind in one eye (making capture easier) and was triumphantly brought home by one of the boys and kept in his father's bird aviary. It soon fed readily on insects, chopped meat and fruit, as well as the occasional quail and finch in the aviary. A new outdoor aviary was rapidly constructed (2 x 6.25m) and was devoted entirely to the first author's small captive reptile collection.

In May 1969 an immature female water dragon (SVL 130 mm) was captured, also at Carroll Creek, and was added to the cage. This lizard was probably a two year old (based on unpublished mark-recapture data) when caught, and had therefore hatched in early 1967. The two water dragons shared the cage with four eastern blue-tongued lizards (*Tiliqua scincoides*), a pair of Cunningham skinks (*Egernia cunninghami*) and four long-necked tortoises (*Chelodina longicollis*). The cage received sun for most of the day, had a 3.2 m2 covered area at one end, and was decorated with logs, rocks, shrubs and a pond. No artificial heating was used, so all lizards had a winter dormancy period typical for this latitude. The lizards were fed about twice a week from September through to early May on a varied diet which included lean minced meat, canned dog food, new-born mice, garden snails, bananas and other soft fruit. In addition to this, the water dragons often caught insects (including flies, grasshoppers, crickets and cicadas) that blundered inside the cage.

The male died in September 1987 (SVL 214 mm; Australian Museum No. R125998), and was successively replaced by a captive-raised adult male in the spring of 1988 (8 Oct. to 28 Nov.), a wild-caught adult male in the spring of 1989 (8 Oct. to 20 Dec.) and a different captive-raised male in September 1990. Only one adult male was ever kept at any one time. This last male was the offspring of the original pair, was three and a half years old at this time and remained with the female until her death in July 1995 (SVL 204 mm; Australian Museum No. R145335). Like the original male lizard, towards the end of her life the female lost weight, became increasingly frail and uncoordinated, and eventually died, presumably from old age.

We recorded dates of oviposition and the number of eggs laid whenever observed. In some years the exact date of laying was not known. Occasionally other lizards in the cage would eat an unknown number of eggs, so the exact clutch size was not recorded. In years where the date of laying and/or number of eggs was not known due to egg predation by cage-mates, oviposition was indicated by the visible decrease in size and mass of the female,

presence of new nesting burrows and egg shell remnants in the cage. As only one female water dragon was kept during this entire time, there is no doubt that this reproductive record is from a single lizard.

CAPTIVE REPRODUCTION

Reproduction was recorded over a 23 year period for this captive female water dragon. From 1971 to 1993 she laid fertile eggs in all years except 1987, when no male was present during the spring. During this season, she laid 7 malformed and decomposing eggs on 2 January 1988. Not including this clutch, the female laid 42 clutches in total, including 33 known complete clutches of between 6 and 12 eggs each (mean=9.06, standard deviation =1.54) during its reproductive life. At the time of first reproduction in November 1971 this female was 166 mm SVL, and in the following reproductive season when she laid her first double clutch she was 178 mm SVL. In each future breeding season (except for the last year of reproduction and in 1987), this female laid two clutches.

The mean date of oviposition for the first clutch each spring was 8 November (SD = 6.8 days, n=19), with extremes of 26 October and 25 November. The mean date for the second clutch was 14 December (SD=9.1 days, n=15), with extremes of 26 November and 1 January (see Fig. 1). For the 14 years where the exact date of oviposition is known for both clutches, the mean interval between successive clutches was 37 days (SD=5.2 days, minimum 30 days, maximum 48 days). For the first and last year of its reproductive life this lizard laid only one clutch; these were laid within the usual period of the first clutch (11 Nov. in 1971 and 22 Nov. in 1993).

Using only data from complete clutches, the first clutch averaged 9.35 eggs (SD=1.69, min 6, max 12, n=20), while for the second clutch it was 8.62 eggs (SD=1.19, min 7, max 11, n=13). Although a comparison using all data revealed no significant difference in mean number of eggs between the first and second clutches (unpaired t=1.36, P=0.185, df=31), a comparison using data from only the 11 years when egg number for both clutches is known revealed that the first clutch was significantly larger than the second (10.00 vs 8.73 eggs, paired t=2.71, P=0.022).

In three years the eggs were removed within an hour of being laid, kept in slightly damp sand overnight, then weighed to the nearest mg the next morning. In one year (1975) the eggs from the first and second clutch did not differ significantly in mass (unpaired t =1.06, P=0.31), but in two subsequent years (1977 & 1978) eggs from the first clutch were significantly heavier than second clutch eggs (unpaired t =9.96, P<0.0001 & t = 6.71, P<0.001 respectively). When all three years are analysed together (ANOVA with clutch number as factor: F1, 56 = 44.9, P<0.0001), eggs from the first clutch are still significantly heavier (mean 4.85g) than from the later clutch (mean 4.36g). See Table 1.

NESTING BEHAVIOUR

It appeared to us that this lizard chose atypically warm and sunny days to finalise her nest site choice and lay her eggs. To investigate this, maximum daily temperature, hours of sun and global radiation records were obtained from the Bureau of Meteorology for Sydney for the 34 known dates of oviposition and the ten previous days for each. The lizards were kept in the Sydney suburb of Naremburn , 5.1 km north of Observatory Hill. As global radiation records for Sydney are only available since 1983, only 17 dates of oviposition are included in this part of the analysis. Global radiation is probably the best indicator of soil temperature (and thus egg incubation temperature) as it is a measure of the total amount of the suns radiant energy arriving at ground level.

As suspected, the female laid her eggs on the day when mean maximum air temperature, global radiation and hours of sun were higher than the mean for any of the previous ten days (Table 2). However, a one factor ANOVA comparing these three variables on the day of laying with the ten previous days showed no significant difference between day of laying and the previous ten days for these three measurements. The first clutch (n=19) was on aver-

age laid on days 2.9°C warmer than the mean of the previous 10 days. By contrast, the second clutch was laid on days with a mean only 1.5°C higher than for the previous 10 days (n=15). This difference is probably due to daily mean temperatures (and hours of sun) increasing more rapidly over an eleven day period in early November than in mid December.

Nesting behaviour was similar each year for this captive female. Nesting burrows would usually be seen about one week before oviposition, but this varied from 3 days to 12 days prior to laying. Several "trial" nesting burrows would appear in various parts of the cage, but eggs would always be laid within a 25 x 25 cm^2 area in the south-east corner of the aviary; this site received the maximum hours of direct sun in the cage. Although nesting burrows were constructed at any time of the day, most activity occurred in the two or three hours before sunset. Similarly, oviposition would invariably begin about one to two hours before sunset and nest filling was often completed after sunset. The final "decision" as to which nesting burrow to use was seemingly made in this last hour or two of daylight. Even when 3 or 4 similar looking nesting burrows were open and available, the female appeared to make the final choice only after investigating the depths of each with her snout.

During construction of the nesting burrow the female would be extremely wary, and would stop all activity and 'freeze' if any disturbance was detected. The front feet were used for excavation, and the back feet for pushing the loose soil away from the burrow. Unlike smaller agamid species that reverse into the prepared nesting burrow for oviposition, this water dragon laid her eggs while fully exposed and laying flat over the prepared burrow. Nesting burrows were typically near vertical and between 75 and 110 mm deep at the bottom, and about 40 to 70 mm wide. The soil was replaced using the back feet, with frequent taps and pushes with the nose to compact the soil. After the nesting burrow was completely refilled, it was difficult to find due to the female scattering dead grass and soil over the entire area.

Nest guarding was observed both during egg laying and for some days after. If either of the two large skink species that shared the cage attempted to eat freshly laid eggs before the nesting chamber was filled in, it would invariably be attacked and bitten aggressively by the female water dragon. This strategy worked well if only one other lizard was involved, but was ineffective if two or more hungry cage-mates arrived at once. Similarly, if we tried to remove eggs by hand from the open nesting burrow while egg laying was in progress, the normally timid female would attack and bite savagely. In Nov. 1977 and Nov. 1985 the eggs were excavated and removed from the nesting burrow by us late at night on the day of laying, and the hole was left open. The female filled in the open nesting burrow again next morning, whereupon we re-opened it again each night. In 1977 the female refilled the open nesting burrow for the next four mornings, and in 1985 for the following three mornings. After this the female paid no further attention to the open nesting burrow.

In 1977 and 1986 the male water dragon was removed to another cage on the day the female laid her first clutch for the season (3 Nov & 31 Oct. respectively) and was not replaced with the female until after the second clutch had been laid (6 Dec & 18 Dec.). In both years all eggs in the second clutch were fertile, suggesting that sperm storage from matings prior to the first clutch can be used to fertilise the second clutch of eggs in this species. The fact that this female did not produce fertile eggs in 1987 after the original male had died in September suggests that sperm storage between seasons does not occur. Courtship by males was only ever observed to occur in the spring. Mating was observed twice: on 8 October 1989 a wild-caught male mated with the female a few minutes after being released into the aviary, and on 19 October 1990 the three and a half year old captive-raised male (SVL 156 mm, mass=160 g) was seen mating with the female. This last mating resulted in only one fertile egg out of a clutch of 12. Matings with this male (the females' son) did however result in fertile eggs in the following three seasons.

Eggs were removed from the nesting burrow shortly after laying each year and incubated at room temperature in containers of either damp sand or moistened vermiculite (in later years), sealed with plastic sandwich wrap and secured with a rubber band. In some years the container received between 1 and 2 hours of early morning sun daily through a window. At these low mean temperatures eggs typically took between 85 and 120 days to hatch. Over many years, several hundred hatchlings were released at Carroll Ck, Forestville.

DISCUSSION

Previous records of longevity for captive eastern water dragons include 14 years (Hay 1972) and 10 and 11 years (Giddings 1983). Slavens (1994) records maximum captive longevity of 10 and 12 years for this species, and the maximum for any agamid as 23 years for an Asian sail-finned lizard (*Hydrosaurus amboinensis*). Interestingly, *Hydrosaurus* is probably the most closely related genus to the Australian *Physignathus* (Watkins-Colwell 1994). Our record of 20 years captivity for the original male (which was captured as an adult and was therefore at least 4-5 years of age at the time), and 26 years for the female suggest that 25 to 28 years may be the upper limit for maximum lifespan.

This female laid her first clutch at a presumed age of four and a half years (ie the spring of her fifth year), while the captive-raised male was three and a half years old (in October 1990) when courtship and mating behaviour were first observed. Hay (1972) also records age at maturity as five years, based on three (presumably female) lizards raised in captivity. Our own experience in raising hatchlings suggests that growth rates vary greatly depending on food quality and availability, temperature, access to sunlight, cage size and the amount of behavioural stress endured due to dominant cage-mates. Under optimum conditions, captive female water dragons have laid their first clutch of eggs at 13 months of age in Alabama (Langerwerf, pers. comm.).

Double clutching in this species has been recorded previously in captivity at similar latitudes (Hay 1972; Australian Reptile Park, G.Husband pers. comm.) and triple clutching has been recorded at Cairns, Qld (T. Hawkes, pers. comm.), near the northern limit of distribution for the species. The double clutching record by Harlow in Anonymous (1976) is for the same female water dragon referred to here. Multiple clutching is common among temperate and tropical agamids both in Australia (Greer 1989) and elsewhere (Dunham *et al.* 1994). The spring timing of reproduction reported here is consistent with reproductive patterns in other families of temperate reptiles (Greer 1989).

Nest guarding and aggression towards a human by a captive female water dragon disturbed during oviposition, and the refilling of a disturbed nest have previously been reported by Giddings (1983); indeed, we regularly see our normally placid and inoffensive captive blue-tongued lizards become aggressive, biting and hissing savagely immediately after parturition. Similarly, friendly captive female diamond pythons may become aggressive, hissing and biting, immediately after oviposition. These maternal brood defence instincts occur widely within the squamates, and have obvious adaptive reasons for evolving and persisting. Nest refilling up to 5 days after parturition may however be an artefact of captivity if a female normally lays her eggs away from her normal home range and then returns. However, nest guarding is well documented in several species of iguanas, and Galapagos land iguanas are known to defend their nest site for periods ranging from a few days to over a month (Christian and Tracy 1982).

Sperm storage by female lizards that results in fertile eggs when no male is available has obvious advantages in species with low population densities. Water dragons however are usually found in large numbers along watercourses in eastern Australia and this adaptation may be rarely necessary. We do not know if females normally mate between successive clutches each season, as the only two matings observed by us were both prior to the first clutch of eggs being laid. In the only agamid species investigated histologically, the

Indian garden lizard *Calotes versicolor*, females have sperm storage pockets in the oviducts (Kumari *et al.* 1990). Sperm storage has also been reported in many other agamids, including the Chinese water dragon (*Physignathus cocincinus*: de Bitter and de Bitter 1986) where fertile eggs have been produced after nearly two years without access to a male. Sperm storage in the related Chameleon family is also well developed, and five successive fertile clutches have been reported from isolated females in one species (*Chamaeleo ellioti*: Leptien 1989), and three in another (*C. hoehnelii*: Jun-yi 1982).

Captive observations such as these, even on a single lizard, provide a valuable adjunct to our limited knowledge of the natural history of the species. For example, the number of clutches laid and the timing of oviposition each year, nesting behaviour and nest site selection in the wild are not recorded for this species. As this is the first lizard identified in Australia to have temperature-dependent sex determination (where the incubation temperature of the eggs determines the gender of the hatchlings: Harlow 1994), nest site choice and the seasonal timing of oviposition are presumably important aspects of the ecology of this species and ultimately for determining the population sex ratio.

Unfortunately, at the time of writing, the keeping of common reptiles, frogs and even tadpoles in captivity is either illegal or bureaucratically outside the reach of children in many states of Australia, so today's children are discouraged from developing any interest in our native fauna and are instead encouraged to spend their leisure hours at McDonald's. Luckily, most parents seemingly disregard these pointless laws and support their children's interests in keeping a pet reptile or frog.

REFERENCES

Anonymous (1976). Observations on the eastern water dragon *Physignathus lesueurii* in the natural state and in captivity. Herpetofauna 8 (2): 20-22.

Christian, K.A., and C.R. Tracy. (1982). Reproductive behaviour of Galapagos land iguanas, *Conolophus pallidus*, on Isla Santa Fe, Galapagos, pp. 366-379. *In* Iguanas of the World, G.M. Burghardt and A.S. Rand (eds.). Noyes Publications, New Jersey, USA.

de Bitter, H., and M. de Bitter. (1986). Bevruchte eieren van twee groene wateragamen, *Physignathus cocincinus*, dankzij spermaopslag? Lacerta 44:74-76.

Dunham, A.E., D.B.Miles, and D.N. Reznic. (1994). Life history patterns in squamate reptiles, p. 441-522. *In:* Biology of the Reptilia, 16, Ecology B. C.G. and R.B. Huey (eds.). Branta Books, Ann Argor, MI.

Giddings, S. (1983). An observed oviposition of an eastern water dragon (*Physignathus lesueurii*). South Aust. Herp. Group Newsletter (Sept):8-9.

Greer, A.E. (1989). The Biology and Evolution of Australian Lizards. Surrey Beatty & Sons Pty Ltd., Chipping Norton, New South Wales.

Harlow, P. (1994). Life history attributes of an agamid lizard with temperature-dependent sex determination. Second World Congress of Herpetology - Abstracts. December 29, 1993 - January 6, 1994:111.

Hay, M. (1972). The breeding of *Physignathus lesueurii* in captivity. Herpetofauna 5 (1): 2-3.

Jun-yi, L. (1982). Sperm retention in the lizard *Chamaeleo hoehnelii*. Copeia 2:488-489.

Kumari, T.R.S., H.B.D. Sakar, and T. Shivanandappa. (1990). Histology and histochemistry of the oviductal sperm storage pockets of the Agamid lizard *Calotes versicolor*. Journal of Morphology 203:97-106.

Leptien, R. (1989). Zur haltung eines weibchens von *Chamaeleo ellioti* mit dem nachweis von amphigonia retardata. Salamandra 15:21-24.

Slavens, F.L. (1994). Reptiles and amphibians in captivity: breeding, longevity and inventory, current January 1, 1994.. Slaveware, Seattle, Washington.

Watkins-Colwell, G.J. (1994). Cladistic biogeography of the water dragons, *Hydrosaurus* and *Physignathus* (Lepidodauria: Agamidae). pp 68. Unpublished MSc. thesis, University of Ohio.

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YEAR	CLUTCH NUMBER	NUMBER OF EGGS	MEAN EGG MASS (SD)
19751	1	12	4.75 (0.109)
	2	7	4.70 (0.099)
19771	1	10	5.07 (0.322)
	2	10	4.01 (0.098)
19781	1	10	4.74 (0.104)
	2	9	4.48 (0.117)
COMBINED	1	32	4.85 (0.245)
MEANS	2	26	4.36 (0.312)

Table 1
Egg mass comparisons (in grams) between first and second clutches for three years, with standard deviation in brackets.

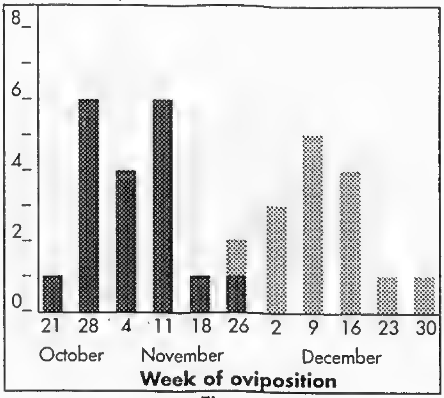

Figure 1
Week of oviposition of first and second clutches of eggs in a captive eastern water dragon

	Mean maximum temperature (oC)	Mean hours of sun	Mean Global Radiation (megajoules m2)
Day of Egg Laying	26.18	8.58	26.91
minus one day	24.41	7.77	23.93
minus two days	24.30	6.89	21.07
minus three days	23.76	6.86	22.31
minus four days	24.55	6.68	19.75
minus five days	23.89	7.07	23.81
minus six days	24.21	8.15	21.57
minus seven days	24.56	8.34	21.86
minus eight days	23.61	8.05	24.73
minus nine days	23.14	7.98	22.63
minus ten days	22.66	6.88	22.15
Sample size	34	31	17
ANOVA P-value	0.067	0.5323	0.342

Table 2
Means for maximum temperature, hours of sun and global radiation on the day of oviposition and for the previous ten days for a captive eastern water dragon over 22 breeding seasons. Sample size and P value given for a single factor ANOVA using day (zero to minus 10) as the factor.

NESTING BEHAVIOUR IN THE EASTERN LONG-NECKED TURTLE *CHELODINA LONGICOLLIS*

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ABSTRACT

The author has witnessed eight separate nesting events or parts thereof, in *Chelodina longicollis* over a three year period at lake Weeroona. While this study describes a single nesting, it appears to be representative behaviour of the turtles at this locality. The gravid *C.longicollis* will leave the water, find a suitable nesting site, excavate an egg chamber, deposit the eggs, backfill the nesting chamber and return to the water. I describe in detail the nesting behaviour of the Eastern Snake-necked Turtle, *Chelodina longicollis*, from Lake Weeroona, Victoria. Comparisons with existing data indicate only minor variations in nesting behaviour which is possibly environmentally related.

INTRODUCTION

The Eastern Snake-necked Turtle, *Chelodina longicollis*, is a common chelid turtle that inhabits coastal and inland waterways and wetlands of eastern continental Australia, from south-eastern South Australia to eastern Queensland (Cogger 1992). *C.longicollis* nest on rainy or overcast days (Ehmann 1992) during spring through to early summer (Cann 1978; Ehmann 1992). Clutch size ranges from 6 to 23 eggs with females nesting up to three times in one season (Parmenter 1985; Ehmann 1992). Hatchlings emerge from the next after 105 to 123 days, following, or during rain that softens the nest plug. The hatchlings wait for darkness before leaving the nest to enter the water (Parmenter 1985).

There have been detailed studies on the nesting behaviour of marine turtles (e.g. Bustard 1972; Carr 1952; Pritchard & Trebbau 1984) however, only anecdotal evidence exists on the nesting behaviour of Australian freshwater turtles, therefore making comparisons difficult. Aspects of the nesting behaviour of *C.longicollis* have been documented (Harrington 1933; Wells 1973; Hill 1979; Kennerson 1979; Beck 1991), but important aspects are still lacking when compared to observations on the nesting behaviour of marine turtles. The aim of this study is to describe in detail the nesting behaviour of *C.longicollis*.

Materials and Methods

This study records a single nesting event of *C.longicollis* which took place at Lake Weeroona (36°42'S, 144°21'E) on 21 December 1994 between 9.30pm and 3.00am (DST). Observations of nesting and egg deposition were made at night, aided by a hand held torch within 1m of the turtle. Lake Weeroona is an ornamental lake, surrounded by parklands, situated in Bendigo (Victoria). This turtle population is possibly derived, in part, from introductions from the Murray River. Nesting was observed after a warm to hot day with early evening rain – daytime high of 27°C after a nighttime low of 23°C, 83% humidity, 13 kmh winds and 0.2mm of rain. During the nesting process it was not raining, except for a few minor mist rains during the first hour of the excavation process. Bendigo was experiencing drought conditions at this time. Soil is chiefly shallow clay to silt with coarse shale amongst grass roots. During the nesting period, the subsoil was dry and hard.

Nesting Behaviour

The turtle was initially observed to leave the water, methodically walking on all four legs. It reached a suitable nesting area which it

explored, walking back and forth or in circles, pausing on occasions until an apparent suitable site had been found. This site was located between Lake Weeroona and the Bendigo Creek, some 26m from the waters edge with no tree cover within 12m. The site sloped towards the creek. The turtle lowered its body so that the plastron was resting on the ground with its head and neck stretched forward. It began to push ground cover back and away from the body with the right rear leg, then changing to the left rear leg and pushing any debris away in a similar fashion. The turtle then began excavation and faced away from the creek throughout the entire nesting event.

Using one rear leg at a time the turtle began scratching the earth with the claws to one side of the rear plastral lobe. The resting leg was either positioned to the rear of the tail or pointed straight back away from the turtle. This was repeated with the opposite leg several times. This digging on each side of the plastral lobe gives the appearance that the turtle is digging two holes. These holes enable the carapace marginals to slot in and allow the back legs to dig deeper at a later period (see below).

The digging process eventually changes to the turtle digging one hole by swinging the anterior part of the body to the side, thereby allowing the closest leg to scratch in the newly formed hole before swinging the anterior part of the body back and using the other leg. The scratching process occasionally 'flicks' loose dry dirt out of the hole, projecting it up to two metres away.

The position of the turtle was as follows: the neck was stretched out and as far forward as possible, one front leg was extended forward while the opposite rear leg was inserted into the egg chamber. The other front leg was extended to the side of the turtle near the bridge and the opposite rear leg was to one side of the egg chamber. As the turtle reached deeper into the egg chamber, the forward front leg was used to tilt the front of the turtle in an upwards direction, thereby allowing the hind leg to reach deeper into the egg chamber. This also resulted in the marginal shield of the carapace rubbing on the ground (the shallow excavation mentioned above) to one side of the hole depending on the tilt.

The turtle used one rear leg at a time in the process of excavating the egg chamber. She inserted the rear leg into the hole and scratched at the bottom of the hole until there was enough mud to lift out. The mud clung to her rear foot as she scooped it out of the hole and she placed her foot to one side of the hole, standing on the mud. While scratching out of the bottom of the egg chamber, the claws pointed back towards the heel of the foot, creating a cup shape. This enabled the turtle to hold a 'sausage' of mud in its foot and lift it out of the hole.

The mud lifted out of the hole by the turtle, and placed to the side of the hole, was not pushed away but oozed away from the hole under the weight of the turtles foot. Each new mud deposit was placed on top of earlier deposits as indicated in Figure 1. The turtle then changed position; the front legs remaining in position while the rear portion of the body moved to insert the opposite leg into the egg chamber. The turtle scraped out all the mud over a short period leaving dry earth. A few more scratches occurred followed by the turtle discharging a small amount of liquid into the hole just before inserting the next leg. The process was then repeated, during which loose clumps of soil fell back into the hole. The liquid discharge helped to hold the loose soil (now transformed into mud) in the foot.

One leg reached deep and scratched towards the 'front' of the hole then pushed the soil to the rear of the hole. The other leg scratched to one side of the hole and scooped out the soil that had been previously pushed to the rear of the egg chamber. As the turtle dug deeper and further forward (under the plastron), both front legs came close to the bridge of the plastron for support and balance. One rear leg was digging and the other was to the side or back of the hole supporting the weight of the turtle.

Once the turtle had excavated a deep hole of around 100mm in depth, the sides and front of

the hole, near the base, were enlarged to form a pear shaped hole measuring about 60mm in diameter at the opening and 80mm in diameter at the base. No liquid discharge was observed at this stage. Some small bits of shale were encountered, but with persistence they were, bit by bit, broken away or dug out.

The digging process was a long and tedious task taking around five hours to complete. Often the turtle paused for intervals of around 10 seconds with one or both legs out of the hole.

Finally, oviposition commenced with the first egg deposited into the egg chamber. The rear leg rolled the egg around the base of the chamber where there was some loose dry soil, until it was in position as shown in Figure 2. The leg was then removed from the chamber and the next egg was deposited. The opposite rear leg was inserted into the chamber to position the new egg. Egg deposition is shown in Figure 3. This process was repeated for around 20 minutes, during which the turtle paused briefly, until 16 eggs had been deposited into the egg chamber.

After all the eggs were deposited into the egg chamber, the turtle paused for about 10 seconds before scraping the now somewhat drier mud back over the eggs. One rear leg was used at a time, the turtle reached out and scraped some dirt into the hole as indicated in Figure 4 before repeating the same process with the opposite rear leg. Once the egg chamber was filled and level with the surrounding ground, the turtle then raised her body and dropped it on the nest plug. The female then methodically returned to the water with no deviation.

Immediately after the nesting had finished, the nest site had fresh earth noticeable between the blades of grass immediately surrounding the nest plug. The action of the turtle scraping the dirt back into the hole also pushed loose or dead grass into the hole which tended to camouflage the nest.

The entire nesting process was captured on still photography with some of the excavation process recorded on video. The author's presence did not appear to greatly affect other nesting turtles observed at Lake Weeroona. Often the nesting turtles would pause and keep a watchful eye on us, even with the disturbance of the flash gun and video lights. Those that we did disturb either returned to the water (after retracting back into the shell for about 20 minutes), found another site to excavate (within ten metres from the original site), or returned to the water after completing the excavation process. Once egg deposition had begun they were in a 'trance-like' state and were oblivious to human presence.

DISCUSSION

Harrington (1933) describes *C.longicollis* as levelling the sand prior to excavation, followed directly by the turtle scratching to the rear and scooping out the sand. Observations at Lake Weeroona indicate similar behaviour with the turtles pushing away any loose ground debris, such as leaves, twigs and grass, before digging to the side of the plastral lobe. Harrington's (1933) observation was on sand, where digging involves less effort. The Lake Weeroona turtles excavated hard soil, thus requiring a force of greater magnitude, achieved by digging to the side of the plastral lobe. In the case of some marine turtles (e.g. *Chelonia mydas* and *Caretta caretta*, Bustard, 1972) and *Podocnemis expansa* (Pritchard & Trebbau, 1984), a body pit is excavated to reduce the likelihood of loose sand falling back into the egg chamber. Body pits have not been recorded in *C.longicollis* possibly due to the soil being firm in comparison to 'beach sand'.

Cloacal discharge to moisten the soil and aid excavation, has been widely observed in the literature (e.g. Wells 1973; Hill 1979; Beck 1991) and does not differ from the observation above, or with other turtles observed at Lake Weeroona. Vestjens (1969) noted in his account that a cloacal discharge did not occur, but in that instance rain softened the soil. Hill (1979) also observed the turtle placing the excavated soil to the back of the hole, whereas

the Lake Weeroona turtles placed the soil to the side where it was then pushed away under the weight of the turtle and further soil deposits.

Waite (1929) described excavation as a drilling process; 'the turtle turning itself round and round and throwing out sand'. Beck (1991) describes a similar technique after an initial depth of 50mm has been scooped out of the hole: 'each time the leg reaches down for a scoop, the tortoise turns 30 to 40° ... the legs alternate with each scoop and turn ... producing an accurately 'machined' hole'. It is uncertain whether Beck's (1991) observation is based on a single nesting event or several, while Waite (1929) fails to mention which limbs, front or rear, did the digging. However the observation of 'drilling' appears to be isolated to these authors. *Pseudemydura umbrina* also has a unique way of nest excavation, using the forelimbs (Kuchling, 1993). *Podocnemis expansa* uses the forelimbs to push the sand back before the hind limbs take over (Pritchard & Trebbau, 1984), this technique may be similar to marine turtles and be an adaptation to nesting in dry soft sands.

Beck (1991) also describes another technique where the turtle uses the rear of the plastron to cut through the mat of roots prior to excavation. This technique has not been recorded in any of the other literature. In this study the rear edge of the carapace 'slotted into holes' and may erroneously be mistaken as cutting through roots.

Several authors describe *C.longicollis* nesting which involved digging with only one rear foot inserted into the hole during the course of excavation, and one rear foot used to place the egg into position in the egg chamber (Hill, 1979; Beck, 1991). Observations at Lake Weeroona verify these reports. Various authors (e.g. Harrington 1933, Kennerson 1979, Wells 1973 & Vestjens 1969) observed that nesting commenced from mid-afternoon until late evening, typically after rain, and no observations of initiating nest construction were observed from dusk to midday.

Minor variations exist between the observations in this study and existing accounts which may be due to environmental factors such as soil structure and weather conditions; this may simply be an adaptation to local conditions.

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REFERENCES

Beck, R.G. (1991). The Common Long-necked Tortoise *Chelodina longicollis*: A comparative study of the morphology and field behaviour of disjunct populations, S.A. Nat. 66(1):4-22.

Bustard, R. (1972). Australian Sea Turtles –Their Natural History and Conservation, Collins, Sydney.

Cann, J. (1978). Tortoises of Australia, Angus & Robertson, Sydney.

Carr, A. (1952). Handbook of Turtles, Cornell University Press, London.

Cogger, H.G. (1992). Reptiles and Amphibians of Australia, 5th Ed., Reed Books, Sydney.

Ehmann, H. (1992). Encyclopaedia of Australian Animals – Reptiles. Angus & Robertson, Sydney.

Harrington, K.H. (1933). Breeding Habits of the Australian Long-necked tortoise. S.A. Nat. 15:25-27.

Hill, I. (1979). Observations on egg-laying in *Chelodina longicollis*. Herpetofauna 11(1):28-29.

Kennerson, K.J. (1969). Notes on egg-laying in *Chelodina longicollis*. Herpetofauna 11(1).

Kuchling, G. (1993). Nesting of *Pseudemydura umbrina*: The Other Way Round, Herpetologica 49(4):479-487.

Pritchard, P.C.H. & Trebbau, P. (1984). The Turtles of Venezuela, Soc. Study of Reptiles & Amphibians, Michigan.

Vestjens, W.J.M. (1969). Nesting, egg-laying and hatching of the Snake-necked Tortoise at Canberra, ACT, Aust. Zool. 15(2):141-149.

Waite, E.R. (1929). The Reptiles & Amphibians of South Australia, Gov. Printer, S.A., pp.38-47.

Wells, R. (1973). Successful hatching of *Chelodina longicollis*. Herpetofauna 5(4):7-8.

Figure 1:

C.longicollis deposits mud removed from the egg chamber during the excavation process.

Figure 2:

The rear leg of the female *C.longicollis* moves the newly laid egg into position.

Figure 3:

The *C.longicollis* egg drops a short distance into the egg chamber.

Figure 4:

The *C.longicollis* scrapes the dirt back over the eggs in the final stage of nesting.

THE CONSERVATION STATUS OF A COASTAL DUNELAND LIZARD FAUNA AT KAITORETE SPIT, CANTERBURY, NEW ZEALAND.

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ABSTRACT

Anecdotal and observational information combined with pitfall trap capture data over two summers indicates that of the four species of lizard present at Kaitorete Spit at least two (*Oligosoma lineoocellatum; Hoplodactylus aff maculatus*) have almost certainly declined over the last 30 years. There is less evidence of a reduction in the population of a third species (*Oligosoma maccanni*) while a lack of information for a fourth species (*Oligosoma nigriplantare polychroma*) means little can be deduced about its population.

INTRODUCTION

During the course of an ecological study on two skink species at Kaitorete Spit (43° 52'S, 172° 21'E), New Zealand, data was collected which has important implications for the conservation status of the four lizard species present in the area; spotted skink (*Oligosoma lineoocellatum;* Dumeril & Dumeril 1851), McCann's skink (*Oligosoma maccanni*) (Hardy, 1977), common skink (*Oligosoma nigriplantare polychroma*) Patterson and Daugherty 1990 and common gecko (*Hoplodactylus aff maculatus*[1]) (Gray 1843). While none of these species could be regarded as endangered or rare nationally there appears to be some areas of concern in relation to the conservation of this fauna at Kaitorete Spit. Unfortunately there is little data which can be used as a baseline for comparison. Information on the past distribution and abundance of lizards in this area is at best descriptive accounts of observations (Morris; 1971, 1974; Lands and Survey, 1984). Despite this, some generalisations based on information gathered in this study, past studies and anecdotal accounts can be made.

There is strong evidence that the spotted skink and common gecko have declined in the last 30 years and McCann's skink may have suffered from a reduction in its population at some time in the recent past although there is less evidence for this.

STUDY AREA

Kaitorete Spit is a narrow strip of land which extends for 28km in an east - west direction, south of Banks Peninsula, Canterbury (Fig. 1). It is a barrier beach that has been formed by deposition and subsequent long shore drift of river gravels. Most of the width of the Spit is made up of shingle terraces dominated by pasture interspersed with areas of scrub. Seaward of these terraces are a series of parallel dune ridges which flatten in to foredunes before descending on to a steep shingle beach. Coverinf the dunes is the native sandbinder pingao (*Demoschoenus spiralis).* A large area of marram grass *(Ammophilia arenaria)* is present at the eastern end of the Spit in the vicinity of the Birdlings Flat township with other smaller colonies further along the Spit.

METHODS

As well as general observations over most of the Spit, pitfall traps were used to sample the lizard populations over the summer of 1991-1992 and 1992-1993 at the base of the Spit in the vicinity of the Birdlings Flat township. The pitfall traps were made from plastic "liver

1 The common gecko is now recognised as a complex of cryptic species (Daugherty; Patterson and Hitchmough, 1994).

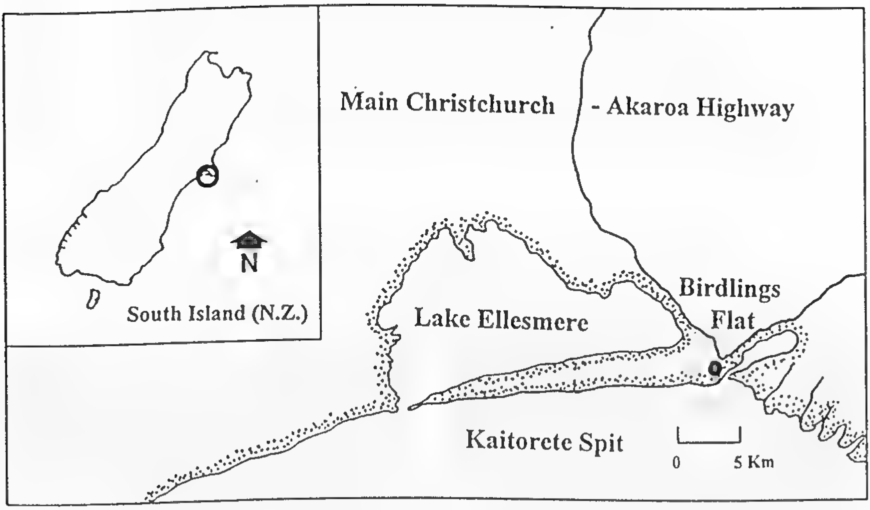

Figure 1: Study area locality

pails", square plastic containers 170mm by 170mm by 190mm. Each was buried so that their double lid (separated by 10mm piece of wood) was at ground level. At the beginning of each trapping session the traps were baited with 1cm cubes of tinned pears (Whitaker, 1967). All lizards captured were permanently marked with an individual toeclip combination. Species, trap location, snout vent length (SVL; measured to the nearest 1mm), weight to the nearest 0.1 gm, and sex were recorded for each lizard captured, which was then released.

RESULTS

A total of 574 lizards were captured in pitfall traps (Table 1). By far the most common species captured was McCann's skink with 510 individuals followed by common skink with 54 individuals and common gecko with 10. No spotted skinks were captured. Six common skinks were also captured by hand. A further 21 common geckos were captured by hand over the period of three years from 1990-1993.

Habitat	O.maccanni	O.n.polychroma	H.maculatus
1991-1992 Duneland	345	-	6
1992-1992 Shrubland	3	29	-
1992-1993 Duneland	159	1	2
1992-1993 Shrubland	3	24	1

Table 1
Total number of lizards captured in pitfall traps in the summers of 1991-1992 and 1992-1993.

General observations over the two summers of the study supported these capture figures. McCann's skink was numerous throughout the dunelands at Birdlings Flat and further up the Spit. Common skinks were regularly observed in the shrublands but with far less frequency than McCann's skink in the dunelands. Spotted skinks were observed only once in the vicinity of the pitfall traps on the edge of the study area opposite the Birdlings Flat township. Three individuals were also observed during the course of the study in dunelands 20 kilometres east along the Spit from the study area.

For common geckos the capture results did not

truly reflect the relative density of this species as common geckos proved relatively easy to capture by hand in both the dunelands and shrublands by searching daytime refugia.

DISCUSSION

Spotted Skink

The most disturbing finding of this study is the apparent decline of spotted skinks at Birdlings Flat. This species was not captured in pitfall traps in either the duneland or shrubland habitats during the course of this study, although one was observed on the edge of the study area opposite the Birdlings Flat township. A single spotted skink was also observed near the study area in February 1991 (pers. obs.). In contrast to this, in 1959-1960 they were 'common' (T. Whitaker, pers. comm.) while in the early 1970's, Morris (1971) collected 30 spotted skinks by hand from the dunelands. The general area where these animals were collected encompassed the duneland sites that were used in this study. Over the 1970's and early 1980's this species was also collected from Birdlings Flat for teaching laboratories at Canterbury University (D. Tattle, pers. comm.).

Failure to capture this species in pitfall traps during this study is thought to reflect the true abundance of spotted skinks rather than result from an inability to capture animals that are present. Spotted skinks have been captured in pear baited pitfall traps in past studies (for example Whitaker, 1967; 1982). Those traps set in the dunelands caught in excess of 500 McCann's skink indicating that they should have at least caught similarly sized spotted skinks if they were present. The fact that this species was observed only once in the vicinity of the study site (despite many hours of searching) during the time of the study also indicates that this species is very rare at Birdlings Flat.

This apparent decline of spotted skinks is further supported by conversations with individuals who have been involved in research and collecting at Birdlings Flat and with local residents. The consensus amongst these people is that spotted skinks are not as common at Birdlings Flat as they once were (D. Tattle, R. Bishop, P. Johns, T. Wilson, pers. comm.).

There is some evidence that the decline of spotted skinks has occurred over a number of years. In 1982, Graham Hardy expressed surprise that Canterbury University people had had difficulty in finding this species at Birdlings Flat (Newman, 1982). He suggested that over-collecting[2] or possibly predation may be the cause of this decline.

Spotted skinks are the largest lizard species present in the study area, with a maximum SVL recorded of 111.0mm[3] (Hardy, 1977). In comparison, the maximum SVLs for the other species are 72.5mm for McCann's skink, 77.0mm for common skinks (Patterson and Daugherty, 1990) and 80.0mm for common geckos (pers. obs.). A number of authors have suggested that those New Zealand lizard species most vulnerable to mammalian predation tend to be large, nocturnal and terrestrial (for example Whitaker, 1978 McCallum, 1986; Towns and Robb, 1986). The spotted skink, while not nocturnal, is the largest lizard on the Spit and is also terrestrial. It is therefore possible that of the species present this is the species most susceptible to mammalian predation.

On Kaitorete Spit there are a suite of potential mammalian predators present including mice (*Mus musculus*), stoats (*Mustela erminea*), weasels (*M.nivalis vulgaris*), ferrets (*M.furo*), house cats (*Felis catus*) and rats (*Rattus sp*) (Lands and Survey, 1984, pers. obs.; D.

2 The suggestion by Hardy that R. Morris removed several hundred of this species from Birdlings Flat is probably wrong. Morris' Msc thesis refers to the collection of only 30 animals (Morris, 1971). However his PhD thesis, carried out on lizards from the same site, does refer to the collection of several hundred Leiolopisma zelandica (*O.maccanni*) (Morris, 1974). This may be the reason for the confusion over the number of animals involved.

3 This figure refers to the maximum SVL of the species as a whole. Animals this size are not necessarily present in the study area.

Hunter, pers. comm.; Fitzgerald, 1964). All of these species are known to include lizards in their diet (Murphy and Pickard, 1990; King, 1990; Lavers and Clapperton, 1990; Fitzgerald, 1990). Furthermore, the impact of mammalian predation on the lizards may be intensified by cyclic changes in predator/prey densities. For example, studies in the McKenzie Basin found that both cats and ferrets ate significantly more lizards after poisoning operations had reduced rabbit populations (Pierce, 1987). Similar rabbit control operations have occurred on Kaitorete Spit (D. Hunter pers. comm.).

However the decline of this species does not appear consistent over the whole of the Spit.[4] During the course of this study spotted skinks were observed in dunelands 20km east along the Spit from the study area. At one locality three animals were observed in just over half an hour of searching. This would seem to indicate that the decline of this species has been most dramatic at the base of the Spit rather than over the Spit as a whole. The township at the base of the Spit may cause more intensive predator pressure on lizards there because of the presence of domestic pets.

Birdlings Flat is the most frequented part of the Spit by both local residents and visitors. A coastal resource investigation classified Birdlings Flat beach as an important locality for recreation (Palmer, 1984). As a result of this recreational use, habitat disturbance by people and vehicles is more acute here than at any other locality along the Spit. The negative impact of this on spotted skinks is unknown but it could be assumed that the disruption of refuges and habitat would impact most severely on spotted skinks, the largest species present.

The large and colourful spotted skink is also possibly being targeted by amateur collectors. Individuals have been observed collecting this species from this area during the late 1980's. (T. Wilson, pers. comm.). During the 1970's and early 1980's this species was collected from the Spit by Canterbury University Zoology Department for laboratories (D. Tattle, pers. comm.).

Common Gecko

The only gecko present in the study area would appear to be common. Despite very few being captured in pitfall traps they were relatively easy to find by systematic searching in both the duneland and shrubland habitats. A rotting log which was present under a macrocarpa (*Cupressus macrocarpa*) tree, twenty kilometres up the Spit from the study site was found to have in excess of thirty geckos in it (pers. obs.). Local Birdlings Flat residents still consider this species to be plentiful (T. Wilson; B. Brown, pers. comm.).

However common geckos have suffered quite severe collection pressure. Throughout the 1970's and early 1980's this species was taken in high numbers (several hundred) from Birdlings Flat for Canterbury University Zoology teaching laboratories (D. Tattle, pers. comm.). The collection of this species had such an impact on the population that the University stopped removing geckos from Birdlings Flat during the mid 1980's because of the apparent decline in numbers (D. Tattle, pers. comm.). It is also known that common geckos are taken from Birdlings Flat for sale in petshops in Christchurch (D. Hunter, pers. comm.). Now that this species has received full legal protection it is hoped that this change in status will end the commercial exploitation of common geckos.

There is also some evidence that individuals in the Birdlings Flat population are smaller than individuals of the same species on Banks Peninsula (Freeman, 1993). This may be an indication that the Birdlings Flat population of geckos may be under some stress, perhaps from predation.

McCann's Skink

This species is the most common lizard found

4 Morris (1971) suggested that the spotted skink is confined to the base of the Spit coinciding with the distribution of the sand scarab *(Percoptus truncatus)*. This is not correct; the species is present at least 20km down lthe Spit (pers. obs.).

on the Spit. In the dunes the density of McCann's skink is between 1050 and 1850/ha (Freeman, 1997) a figure comparable to that for other 'common' skink species in New Zealand (for example; Barwick 1959; Porter 1987). However, while this animal is very common there are some indications that the population is not as stable as it once was. Morris (1974) in his work on *Leiolopisma zelandica* (which judging from where it was collected was almost certainly McCann's skink) describes collecting individuals of 77mm SVL. This size is considerably more than the maximum of 65mm SVL recorded for this species in the present study and is closer to this species' maximum SVL of 72.5mm as documented by Patterson and Daughterty (1990). This may indicate that the older animals and larger cohorts have been removed from the population as a result of predation.

Common Skink

The common skink appears to be uncommon on the Spit as the number captured was significantly less than the closely related McCann's skink; 5.6/100 trap nights compared to 54.2/100 trap nights (Freeman, 1997). Totals captured at Birdlings Flat are also considerably less than those recorded for common skinks captured in pitfall traps in similar habitat at Pukerua Bay in Wellington (Towns and Elliot, 1996). Unfortunately, there is no previous data available on the density of this species at Birdlings Flat which can be used as a comparison. It is therefore impossible to know if the current low density reflects the natural population size or is indicative of a population under stress.

CONCLUSION

On a national scale none of the species present at Birdlings Flat is thought to be endangered. The spotted skink however should be considered as rare on the mainland with many populations now appearing to have localised distributions (T. Whitaker, pers. comm.). Because of this any mainland population will have some conservation value. That this species has almost disappeared from an area where it was once relatively common is of concern and is perhaps an indicator of changes that are occurring in other mainland populations of spotted skinks in the wake of ongoing, human induced, modification of the environment. Such declines have already been documented in other New Zealand lizards and it is currently thought that up to 40% of extant New Zealand lizard species are endangered, rare or threatened (Towns and Daugherty, 1994).

McCann's skink is very common on the Spit and it is unlikely that this species would become locally extinct in the near future. Common skinks are rare on the Spit, however, their widespread distribution and high density at other localities should ensure their survival on the mainland in the long term. As the common gecko is currently under revision its status will change in the near future. What implications this has for the species present on Kaitorete Spit is not known. This animal does seem to be present in reasonable numbers despite being the target of relatively intense collecting pressure over the last 20 years.

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REFERENCES

Barwick, R.E., 1959. The life history of the common New Zealand skink *Leiolopisma zelandica* (Gray, 1843). Transactions of the Royal Society of New Zealand 86: 331-380.

Daugherty, C.H., Patterson, G.B. and Hitchmough, R.A., 1994. Taxonomic and conservation review of the New Zealand Herpetofauna. New Zealand Journal of Zoology 4: 317-323.

Fitzgerald, B.M., 1964. Ecology of mustelids in New Zealand. Unpublished MSc thesis, University of Canterbury.

Fitzgerald, B.M., 1990. House Cat. Pp330-348 in King, C.M. (ed) The handbook of New Zealand mammals. Oxford University Press, Wellington. 600p.

Freeman, A.B., 1993. Size difference between populations of *Hoplodactylus maculatus* in Canterbury, New Zealand. Herpetofauna 19-15.

Freeman, A.B., 1997. Comparative ecology of two *Oligosoma* Girard skinks in Coastal

Canterbury: a contrast with Central Otago. New Zealand Journal Ecology (In Press).
Hardy, G.S., 1977. The New Zealand Scincidae (Reptilia: Lacertilia); a taxonomic and zoogeographic study. New Zealand Journal of Zoology 4: 221-325.
Innes, J.G., and Hay, J.R., 1991. The interactions of New Zealand forest birds with introduced fauna. Pp 2523-2533 in B.D.Bell.; Cossee, R.O.; Flux, J.E.C.; Heather, B.D.; Hitchmough, R.A.; Robertson, and Williams, J.J. (eds) ACTA XX Congressus Internationalis Ornithologici, Christchurch, New Zealand, 2-9 December 1990. Volume IV. New Zealand Ornithological Congress Trust Board
King, C.M., 1990. Stoat. Pp 288-312 in King, C.M. (ed) The Handbook of New Zealand mammals. Oxford University Press, Wellington. 600p.
Lands and Survey, Department of, 1984. Kaitorete Spit scientific reserve management plan. New Zealand Department of Lands and Survey, Management Plan No. SCR 4.36p.
Lavers, R.B., and Clapperton, B.K., 1990. Ferret. Pp 320-330 in King, C.M. (ed) The handbook of New Zealand mammals. Oxford University Press, Wellington. 600p.
McCallum, J., 1986. Evidence of predation by kiore upon lizards from the Mokohinau Islands. New Zealand Journal of Ecology 9: 83-87.
Morris, R.W., 1971. On some aspects of the biology, thermal relations and thermophysiology of *Leiolopisma lineoocellatum*. Unpublished MSc thesis, University of Canterbury. 71p.
Morris, R.W., 1974. Some aspects of the thermophysiology of the skink *Leiolopisma zelandica*. Unpublished Phd thesis, University of Canterbury.
Murphy, E.C., and Pickard, C.R., 1990. House mouse. Pp 225-242 in King, C.M. (ed) The handbook of New Zealand mammals. Oxford University Press, Wellington. 600p.
Newman, D.G., 1982. Lizard discussion: protection, legislation and research priorities. Pp 445-462 D.G. Newman 9ed.) New Zealand Herpetology. Proceedings of a Symposium held at Victoria University of Wellington 19-31 January 1980. New Zealand Wildlife Service Occasional Publication No. 2, 495p.
Palmer, D.G., 1984. Akaroa and Wairewa counties. Coastal resource investigation. Department of Lands and Survey, Christchurch. 91p.
Patterson, G.B., and Daugherty, C.H., 1990. Four new species and one new subspecies of skink, genus *Leiolopisma* (Reptilia: Lacertilia: Scincidae) from New Zealand. Journal of the Royal Society of New Zealand 20: 65-84.
Pierce, R.J., 1987. Predators in the Mackenzie Basin; their diet, population dynamics and impact on birds in relation to the abundance and availability of their main prey (rabbits). Unpublished report, Wildlife Service, New Zealand Department of Internal Affairs, Wellington. 110p.
Porter, R., 1987. An ecological comparison of two Cyclodina skinks (Reptilia: *Lacertilia*) in Auckland, New Zealand. New Zealand Journal of Zoology 4: 493-507.
Towns, D.R., and Robb, J., 1968. The importance of northern offshore islands as refugia for endangered lizard and frog species. Pp 197-210 in Wright, and A.E., Beever (eds) The offshore islands of northern New Zealand; proceedings of a symposium convened by the Offshore Islands Research Group in Auckland, 10-13 May 1983. New Zealand Department of Lands and Survey Information Series No. 16. 255p.
Towns, D.R., and Daugherty, C.H., 1994. Patterns of range contractions and extinctions in the New Zealand herpetofauna following human colonisation. New Zealand Journal of Zoology 4: 325-339.
Towns, D.R., and Elliot, G., 1996. Effects of habitat structure on distribution and abundance of lizards at Pukerua Bay, Wellington. New Zealand Journal of Ecology 2: 191-206.
Whitaker, A.H., 1967. Baiting pitfall traps for small lizards. Herpetologica 4: 309-310.
Whitaker, A.H., 1978. The effects of rodents on reptiles and amphibians. Pp 75-88 in Dingwell, P.R., Atkinson, I.A.E., Hay, C. (eds) The ecology and control of rodents in New Zealand Nature Reserves. New Zealand Department of Lands and Survey Information Series No. 4. 237p.
Whitaker, A.H., 1982. Interim results from a study of *Hoplodactylus maculatus* (Boulenger) at Turakirae Head, Wellington. Pp 363-374 in Newman, D.G. (ed.) New Zealand Herpetology. Proceedings of a Symposium held at the Victoria University of Wellington 29-31 January 1980. New Zealand Wildlife Service Occasional Publication No. 2. 495p.

BASKING AND DIURNALITY IN FROGS: OBSERVATIONS IN THREE SPECIES

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INTRODUCTION

The majority of terrestrial frog species are known to be nocturnal (Duellman & Trueb 1986, p.198). The prevalence of this activity pattern over diurnality is thought to be primarily an adaptation to minimising cutaneous water loss (Tyler 1976, p.120, 1978, p.11, Duellman & Trueb 1986, p.198). It may be expected therefore that frog species which engage in daytime activity occupy habitats receiving little solar radiation, have unrestricted access to water or saturated air, or else they have some special adaptation which substantially reduces water loss (e.g., waterproof skin; Withers et al. 1984, Duellman & Trueb 1986, pp.204-6, Withers 1995). Similar expectations would apply to basking behaviour in frogs where individuals expose themselves to direct sunlight for extended periods but are otherwise inactive. Basking and diurnality in frogs are of interest because they reflect potentially conflicting demands to maintain an appropriate body temperature, while also avoiding dehydration (Duellman & Trueb 1986, p.204, 210). Basking behaviour has also been examined (along with a number of environmental and life-history characteristics) in the context of reported declines in a number of frog species along the east coast of Australia (Mahony 1996).

Amongst the Australian frog fauna basking and diurnality have received only a cursory treatment (e.g., Roberts 1993, Tyler & Davies 1993). Daytime vocalisation has been commonly reported in various frog species and will not be dealt with in this work. Basking and diurnality (other than vocalisation) have been reported in a number of Australian frog species and these are listed in Table 1. As nearly all the listed species are also known to be nocturnal they are perhaps best described as being "noctidiurnal" in habit (as in Cogger et al. 1983). A further distinction can be made between diurnal species which are active in open (e.g., *L.raniformis)* versus secluded situations (e.g., *T.rheophilus)* however reports were often unclear in this respect and the distinction is therefore not made in the table. The table indicates that basking and diurnality have been reported in many more hylidae than myobatrachidae species. It will be noted that this list includes all species in the *L.aurea* complex, (see Barker, Grigg & Tyler 1995, p.99, Thompson et al. 1996), 2 of 4 species of the *L.bicolor* complex, (see Barker, Grigg & Tyler 1995, p.117), 4 of 6 species of the genus *Taudactylus*. It is evident from the various reports that there are few species that are known to habitually engage in daytime activity (e.g., *L.meiriana, T.diurnis)* and a large number of species that seem to do so only occasionally (i.e., at certain times of the year). There are other references in the literature that possibly describe basking or diurnality but the details were unclear and therefore they were not included in the table. Furthermore even in those reports where it is clear that either basking or diurnality had been observed, the circumstances and details surrounding the observations are often lacking. Tyler (1978, p.11) states that many nocturnal species modify their behaviour and become day-active during brief mating periods. I have for example observed both *Crinia signifera* and *Litoria ewingii* active and amplexing during daylight hours but only following heavy rains which had stimulated intense breeding activity. These species are not included in the table and it is likely that the observations of several species listed in the table occurred under similar circumstances. This simply highlights the importance of the context in which observations take place. Additional observations

detailing the circumstances are needed to either confirm, deny or clarify a number of existing reports.

In this article I describe observations of basking in *Litoria tornieri* and diurnality in *Uperoleia arenicola.* Some observations, additional to previously published notes on basking in *L.bicolor* are also presented. Observations occurred at several locations within Kakadu National Park (Stage 1) and Nitmiluk (Katherine Gorge) National Park in the Northern Territory during a visit between 7-27 January 1996. All times are given in Central Standard Time (CST). Brock (1993) and Brennan (1986) were used to identify the main vegetation types at each locality. A list of the herpetofauna of Kakadu NP is given in Braithwaite et al. (1991) along with habitat preferences of the frog species dealt with here. Sizes quoted refer to snout-urostyle lengths. RH denotes relative humidity.

OBSERVATIONS

The observations of basking in *L.tornieri* occurred along the upper section of Barramundi Creek (132°22'E, 13°23'S), partway up into the sandstone plateau complex, in Kakadu NP on 16 January between 1400-1600hrs. The habitat consisted of Darwin Woollybut *(Eucalyptus miniata)*, Spiral Pandan *(Pandanus spiralis)* with a tall grass understorey immediately adjoining the creek that was lined by River Pandan *(P.aquaticus)* and Weeping Paperbark *(Melaleuca leucadendra)*. Grasses extended down to the wateris edge. In the sections examined the creek was shallow (<1m) and slow flowing with a sandy substrate. On the day the observations occurred the area was in full sun with no cloud cover. Air temperature was 34°C and RH about 80%. The area had not received rain in the last 24hrs (at least).

Three adult *L.tornieri* were observed at rest on the leaves and stems of vegetation exposed to full sun. All frogs were located within 0.3m of the water's edge. There was ample moist, shaded and protected areas amongst the vegetation. The frogs were completely inactive, their eyes were retracted and covered by the lower eye-lid, their skin was moist and they were all in their light colour phase (see Barker et al. 1995, pp.77-8). Disturbing the vegetation which frogs were resting on resulted in them becoming alert and one responded by immediately jumping into the water. Two additional sightings, of what appeared to be adult *L.tornieri,* involved frogs jumping from streamside vegetation when accidentally disturbed into the creek and then swimming across the surface before seeking refuge in emergent sedge.

The observation of diurnality in *U.arenicola* occurred on 10 January at Baroalba Creek (132°56'E, 12°47'S), Kakadu NP. The creek drains a large outlier massif that has an extensive Kambolgie sandstone basin located a few kilometres away from the edge of the Arnhem plateau. Bare, flat sandstone faces abut the creek and boulder screes line the edges of the basin with extensive sandstone ridges on both sides. The soil is sandy and shallow. The vegetation is typical of the sandstone plateau comprising xeric-adapted species *Acacia* spp., *Calytrix decessata, Grevillea pteridifolia, Melaleuca* spp., Sandstone Pandan *(Pandanus basedowi)* and patches of Hammock grass (*Plectrachne/Triodia* spp.) and Resurrection grass (*Micraira* sp.). The area had not received rain during the past three days (at least) but heavy early morning ground dews occurred. The morning was slightly overcast.

At approximately 1100hrs a stop was made at a small grass mat in the shade of a large sandstone slab with an overhanging ledge, situated a short distance up a gently inclined side of the basin. The shade and protection of the sandstone boulders had led to the creation of a cool and moist microhabitat supporting mesic/shade-adapted vegetation including mosses and lichens, while only meters away were the very hot and dry conditions of exposed sandstone faces. It was around the shaded base of the boulders that *U.arenicola* were observed to be active. In a $2m^2$ patch of a grassy mat three *U.arenicola* were located. Their sizes were 20, 22, 23mm. We were initially alerted to them by their small jumping

movements. Each frog was alert and active. One frog was observed to eat a small dipteran that it had apparently sighted on a grass stem several centimetres from it. The frogs were each about 30-40cm apart. No interactions were observed between them. For the 10-15min period the frogs were observed they did not venture out from the grass mat and all had moved <1m. When approached they responded by attempting to jump away more rapidly. Other than possibly foraging, the purpose of the observed activity was obscure. The nearest standing ground water was some 60m away. Air temperature at ground level was 24°C, RH 70%, while on the nearby exposed sandstone it was 37°C. The species was not vocal during the day though their rasping call was heard during the evening.

A further two sightings of individual *U.arenicola* occurred within two hours of the first in similar circumstances. Specimens were located around the base of sandstone boulders and slabs in the open and were active.

Basking in *Litoria bicolor* was recorded on two separate occasions. The first took place along the southern perimeter of Nourlangie Rock (132°50'E, 12°52'S), Kakadu NP on 7 January at 1705hrs. The air temperature was in the low 30's with no breeze or cloud cover and RH 80-90%. The area had not received rain in the last 24hrs and there was no rain that evening. The habitat was mixed *Acacia-Eucalyptus* woodland with recently burned tall grassy understorey growing on a fine white sandy substrate. For the entire afternoon the area was in full sun. The nearest standing water was 150m away.

A single *L.bicolor* was sighted perched about half-way up a 0.8m tall main stem of a juvenile *Acacia* tree. It was stationary and lay quite compactly against the thin stem (8mm in diameter) which was exposed directly to sunlight. The ground immediately surrounding the *Acacia* was exposed dry sand lacking any substantial litter layer and there did not appear any moist retreats in the immediate vicinity. It was possible for the frog to avoid direct sunlight by altering its position on the stem by simply swivelling around to the opposing side that was partly shaded. It did not appear dehydrated and its skin was quite moist and in light colour phase. The frog was observed for a10min period during which time it did not alter its position, appearing to be asleep (with eyes retracted). The frog measured 21mm.

The second observation occurred at Dunlop's Swamp (132°31'E, 14°16'S), Nitmiluk NP (3.7km south of the 3rd gorge) on 24 January 1996 at around 1730hrs. The area was exposed to full sun throughout the day with air temperature 36°C, no breeze and RH about 80%. It had rained heavily the previous evening, but not at all during the day. At the time of the observation storm clouds were approaching from the north, though the area received only 2mm of rain some four hours later that evening. A small chorus of *L.bicolor* was heard early in the evening.

A single adult *L.bicolor* was observed approximately 2.5m from the ground perched on a dead dry frond of a *Pandanus spiralis*. The frog was in full sun, alert and did not move during my approach. The nearest water body was some 40m away and none was observed in leaf axils of the pandan that may have been accessible to the frog.

DISCUSSION

Many accounts of basking behaviour in hylids describe frogs in the typical resting/sleeping posture with limbs withdrawn flush against the body cavity, the hands and feet tucked underneath the body, eyes retracted, etc.. This posture appears widespread in hylid frogs when at rest (Tyler 1976, p.121, Duellman & Trueb 1986, pp.198-99, Tyler 1994, p.95). It has been referred to as a "water-conserving" posture because it is generally thought, and in some species has been demonstrated (e.g., *L.rubella,* Withers 1995), to reduce cutaneous evaporative water loss. None of the accounts of hylids describe modified postures associated with basking. However a posture in which the rear limbs are outstretched from the body has

been observed in *N.melanoscaphus* (pictured in Tyler 1976; plate 14-lower) and interpreted as an attempt to maximise the body surface exposed to the sun, thereby raising the body temperature (Tyler 1994, p.95). Many frog species are capable of marked colour change and this may be an important characteristic of frog species that engage in basking, though few reports seem to remark on this aspect. In particular it may prevent overheating (see Withers 1995).

The observations of basking in *L.tornieri* appear typical of those recorded in other hylids (cf., Tyler et al. 1983, Valentic 1995). However the observations of basking in *L.bicolor* are not, with individuals located in dry situations which seemingly lacked moist microhabitats. Other authors have also noted this. Cogger (1992, p.129) states: "During the dry season specimens are found in or on vegetation, especially in the leaf axils of Pandanus palms or on the exposed upper surfaces of broad-leafed shrubs, even in hot, dry conditions". There is an accompanying photograph of a specimen in "Diurnal resting position in hot sun". Frith & Frith (1987, p.9) comment: "The frog is primarily a leaf and plant stem-dwelling species that can be found in quite hot and dry situations". Cameron & Cogger (1992, p.16) noted the occurrence of *L.bicolor* "on exposed leaves on dunefield woodland during the day, in air temperatures of about 30°C". They also noted that the species is able to withstand high water temperatures and that "frogs when disturbed dived into water of approximately 35°C and swam off". Morris (1996, p.129, 138) comments on the "tenacity" of this species in hot dry weather. It is curious that *L.bicolor* is able to tolerate such conditions since smaller frogs tend to dehydrate more rapidly than larger ones, a consequence of their higher surface area to volume ratio (Duellman & Trueb 1986, p.203). It is possible that their small size enables them to utilise moist microhabitats that have escaped the attention of observers. The observations suggest *L.bicolor* would make an interesting candidate for physiological studies of thermal tolerance and evaporative water loss.

It seems likely that Goodfellow (1993, p.85) observed basking in *L.tornieri,* noting that "there were hundreds in the grass along the Arnhem Highway near the South Alligator River during daylight". On the other hand I have been unable to locate a reference to diurnality in any of the *Uperoleia* species. Tyler et al. (1981a) commented that "individuals of most species pass the daytime beneath the surface of the ground" though they did find *U.aspera* and *U.mjobergi* beneath ground debris during the day. Tyler et al. (1981b) state that *U.arenicola* inhabits sandy soils, emerges at dusk and calls from within burrows.

Tropical wet-season conditions with high humidity, regular rain and abundant ground water, would seem conducive to basking and diurnality in frogs. A number of observations of basking in frogs have occurred under such conditions. For example, Tyler et al. (1983) observed both *C.australis* and *L.dahlii* as commonly basking in the sun at the edge of pools during the wet-season at Magela Creek in Kakadu NP. It would be of interest to know whether, and to what extent, basking is continued through the dry-season. Cameron & Cogger (1992, p.16) located several *L.bicolor* under bark of trees in the dry season suggesting that basking is discontinued, while Morris (1996, p.129) stated that they can still be seen during the day sitting in the leaf-shafts of Pandanus thickets in the late dry-season. These observations occurred in two widely separated localities (Weipa, QLD and Kakadu NP) and may be due to differences in habitat or local climatic conditions- without further details it is not possible to determine.

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TABLE 1.

A list of Australian frog species in which basking and/or diurnality (other than vocalisation) has been reported. Primary references are provided for most species though they should not be considered exhaustive. Also listed are species that are referred to in Cogger et al. (1983), as "noctidiurnal" and where this source appears I have been unable to locate a primary reference. Since it would appear that the term "noctidiurnal" as used by Cogger et al. (1983), includes diurnal vocalisation not all species given this descriptor are listed. A number of species are included in the list for which the primary source does not give details of the observed behaviour but nonetheless does contain an explicit statement to the effect that the species was found away from refugia during daylight hours.

The following abbreviations are used:
B=basking,
A=diurnal,
A*=strictly diurnal; Where the details of the behaviour are lacking,
U=undetermined.

Nomenclature follows Cogger (1992) which in regard to the species listed departs from Barker et al. (1995) in the following respects: *Litoria castanea* and *Litoria dorsalis* are considered senior synonyms of *Litoria flavipunctata* and *Litoria microbelos* respectively (see Cogger et al. 1983, pp.41-3, Thomson et al. 1996).

SPECIES	BEHAVIOUR	REFERENCES
Litoria adelaidensis	B	Bush et al. 1995
Litoria alboguttata	UA	Cogger et al. 1983, Robinson 1993
Litoria aurea	AB	Cogger 1975, Hoser 1989, Hero et al. 1991, Daly 1995
Litoria bicolor	AB	Fletcher 1889, Copland 1957, Moore 1961, Cogger 1975, Cameron & Cogger 1992
Litoria caerulea	UB	Krefft 1863, Shine et al. 1989
Litoria castanea	B	Barker & Grigg 1977 (Plate 7), Mahony 1996
Litoria chloris	B	Buttemer 1990
Litoria citropa	U	Fletcher 1889
Litoria cyclorhycha	AB	Krefft 1863
Litoria dahlii	B	Tyler et al. 1983
Litoria dorsalis	A	Cameron & Cogger 1992
Litoria fallax	UB	Moore 1961, Hoser in Valentic 1995
Litoria freycineti	A	Fletcher 1889
Litoria gilleni	B	Valentic 1995
Litoria gracilenta	B	Tyler 1976
Litoria latopalmata	U	Fletcher 1889, Daly 1995
Litoria lesueuri	UB	Fletcher 1889, Martin et al. 1966, Gillespie 1992
Litoria meiriana	A	Cogger 1975
Litoria moorei	A	Cogger 1975
Litoria peronii	B	Krefft 1863
Litoria phyllochroa Form A (Littlejohn 1967)	AB	Hero & Gillespie 1993
Litoria raniformis	AB	Courtice & Grigg 1975, Hoser 1989, Hero et al. 1991
Litoria rothii	B	Tyler & Davies 1986, Tyler 1992
Litoria rubella	B	Main in Withers 1995, Valentic 1995
Litoria spenceri	AB	Hero et al. 1991, Gillespie 1992, Ehmann et al. 1992
Litoria tornieri	UB	Goodfellow 1993, This work
Cyclorana australis	AB	Tyler et al. 1983, Tyler 1992
Cyclorana platycephala	A	van Beurden 1982
Limnodynastes ornatus	A	Cameron & Cogger 1992
Notaden melanoscaphus	B	Tyler 1976 (plate 14-lower), 1994
Taudactylus acutirostris	AB	Liem & Hosmer 1973, Ingram 1980
Taudactylus diurnus	A*B	Straughan & Lee 1966, Liem & Hosmer 1973, Ingram 1980
Taudactylus eungellensis	AB	Liem & Hosmer 1973, Ingram 1980
Taudactylus rheophilus	A	Liem & Hosmer 1973, Hero & Fickling 1994
Uperoleia arenicola	A	This work

REFERENCES

Barker, J. & Grigg, G.C. (1977) A Field Guide to Australian Frogs. Rigby. Adelaide SA. 229pp.

Barker, J., Grigg, G.C. & Tyler, M.J. (1995) A Field Guide to Australian Frogs. Surrey Beatty & Sons. Chipping Norton NSW. 407pp.

Beurden, E. van (1982) Desert adaptations of *Cyclorana platycephalus:* an holistic approach to desert-adaptation in frogs. In Evolution of the Flora and Fauna of Arid Australia, W.R.Barker & P.J.M.Greenslade (eds.), pp.235-9. Peacock Publications. Adelaide SA.

Braithwaite, R.W., Friend, G.R. & Wombey, J.C. (1991) Reptiles and Amphibians. In Monsoonal Australia: Landscape, Ecology and Man. M.G.Ridpath, C.D.Haynes and M.A.J.Williams (eds.), pp.109-24. Balkema. Rotterdam, Netherlands.

Brennan, K. (1986) Wildflowers of Kakadu. K.Brennan. Jabiru NT. 127pp.

Brock, J. (1993) Native Plants of Northern Australia. Reed. Chatswood NSW. 355pp.

Bush, B, Maryan, B., Browne-Cooper, R. & Robinson, D. (1995) Reptiles and Frogs of the Perth region. University of Western Australia Press. Perth WA. 226pp.

Buttemer, W.A. (1990) Effect of temperature on evaporative water loss in the Australian tree frogs *Litoria caerulea* and *Litoria chloris.* Physiol.Zool. 63: 1043-57.

Cameron, E.E. & Cogger, H.G. (1992) The Herpetofauna of the Weipa Region, Cape York Peninsula. Technical Reports of the Australian Museum, No.7. Australia Museum. Sydney NSW. 200pp.

Cogger, H.G. (1975) Reptiles and Amphibians of Australia. Reed. Sydney NSW. 584pp.

Cogger, H.G. (1992) Reptiles and Amphibians of Australia. 5th Edition. Reed. Sydney NSW. 775pp.

Cogger, H.G. Cameron, E.E. & Cogger, H.M. (1983) Zoological Catalogue of Australia. Vol 1- Amphibia & Reptilia. Australian Government Publishing Service. Canberra ACT. 313pp.

Copland, S.J. (1957) Presidential address. Australian tree frogs of the genus *Hyla.* Proc.Linn.Soc.NSW 82(1): 9-108.

Courtice, G.P. & Grigg, G.C. (1975) A taxonomic revision of the *Litoria aurea* complex (Anura: Hylidae) in South-Eastern Australia. Aust.Zool. 18(3): 149-63.

Daly, G. (1995) Observations on the Green and Golden Bell-frog, *Litoria aurea* (Anura: Hylidae). Herpetofauna 25(1): 2-9.

Duellman, W.E. & Trueb, L. (1986) Biology of Amphibians. McGraw-Hill. New York, USA. 670pp.

Ehmann, H., Ehmann, J. & Ehmann, N. (1992) The Rediscovery of the endangered Spotted Tree frog (*Litoria spenceri*) in New South Wales and some subsequent findings. Herpetofauna 22(2): 21-4.

Fletcher, J.J. (1889) Observations on the oviposition and habits of certain Australian Batrachians. Proc.Linn.Soc.NSW 4(2): 357-87.

Frith, C.B. & Frith, D.W. (1987) Australian Tropical Frogs and Reptiles. Frith & Frith Books. Malanda Qld. 71pp.

Gillespie, G.R. (1992) Survey for the Spotted Tree frog (*Litoria spenceri*) in Victoria, February-March 1992. Vict.Nat. 109(6): 203-11.

Goodfellow, D. (1993) Fauna of Kakadu and the Top End. Denise Goodfellow/ Wakefield Press. Darwin NT. 102pp.

Hero, J-.M. & Fickling, S. (1994) A Guide to the Stream-dwelling Frogs of the Wet Tropics Rainforest. Department of Zoology, James Cook University. Townsville Qld. 27pp.

Hero, J-.M. & Gillespie, G. (1993) The tadpole of *Litoria phyllochroa* (Anura: Hylidae). Proc.Roy.Soc.Vict. 105(1): 31-8.

Hero, J-.M., Littlejohn, M. & Marantelli, G. (1991) Frogwatch Field Guide to Victorian Frogs. Department of Conservation and Environment. East Melbourne Vic. 108pp.

Hoser, R.T. (1989) Australian Reptiles and Frogs. Pierson and Co. Mosman NSW. 238pp.

Ingram, G. (1980) A new frog of the genus *Taudactylus* (Myobatrachidae) from mid-eastern

Queensland with notes on the other species of the genus. Mem.Qld.Mus. 29: 111-9.

Krefft, G. (1863) On the batrachians occurring in the neighbourhood of Sydney, with remarks upon their geographic distribution. Proc.Zool.Soc.London 1863: 386-90.

Liem, D.S. & Hosmer, W. (1973) Frogs of the genus *Taudactylus* with descriptions of two new species (Anura: Leptodactylidae). Mem.Qld.Mus. 16(3): 435-57.

Littlejohn, M.J. (1967) Patterns of zoogeography and speciation in the south-eastern Australian amphibia. In Australian Inland Waters and their Fauna, A.H.Weatherly (ed.), pp.150-74. Australian National University Press. Canberra ACT.

Mahony, M. (1996) The decline of the Green and Golden Bell frog *Litoria aurea* viewed in the context of declines and disappearances of other Australian frog. Aust.Zool. 30(2): 237-47.

Martin, A.A., Littlejohn, M.J. & Rawlinson, P.A. (1966) A key to the anuran eggs of the Melbourne area, and an addition to the anuran fauna. Vict.Nat. 83(6): 312-5.

Moore, J.A. (1961) The frogs of eastern New South Wales. Bull.Amer.Mus.Nat.Hist. 121(3): 149-386.

Morris, I. (1996) Kakadu National Park, Australia. Steve Parish natural history guide. Steve Parish Publishing. Fortitude Valley QLD. 225pp.

Roberts, J.D. (1993) Natural history of the Anura. In Fauna of Australia. Volume 2A Amphibia & Reptilia, C.J.Glasby, G.J.B.Ross & P.L.Beesley (eds.), pp.28-34. Australian Government Publishing Service. Canberra ACT.

Robinson, M. (1993) A Field Guide to Frogs of Australia. From Port Augusta to Fraser Island including Tasmania. Australian Museum & Reed Books. Chatswood NSW. 112pp.

Shine, C., Ross, G., Harlow, P. & Shine, R. (1989) High body temperatures in an Australian frog, *Litoria caerulea*. Vict.Nat. 106(4): 138-9.

Straughan, I.R. & Lee, A.K. (1966) A new genus and species of leptodactylid frog from Queensland. Proc.R.Soc.Qld. 77(6): 63-6.

Thomson, S.A., Littlejohn, M.J., Robinson, W.A. & Osborne, W.S. (1996) Taxonomy of the *Litoria aurea* complex: a re-evaluation of the Southern Tableland populations of the Australian Capital Territory and New South Wales. Aust.Zool. 30(2): 158-69.

Tyler, M.J. (1976) Frogs. The Australian Naturalist Library, Collins. Sydney NSW. 256pp.

Tyler, M.J. (1978) Amphibians of South Australia. South Australian Government Printer. Adelaide SA. 84pp.

Tyler, M.J. (1992) Encyclopedia of Australian Animals - Frogs. Angus & Robertson. Pymble NSW. 220pp.

Tyler, M.J. (1994) Australian Frogs - A natural history. Reed Books. Chatswood NSW. 192pp.

Tyler, M.J., Crook, G.A. & Davies, M. (1983) Reproductive biology of the frogs of Magela Creek system, Northern Territory. Rec.S.Aust.Mus. 18: 415-40.

Tyler, M.J. & Davies, M. (1993) Family Hylidae. In Fauna of Australia. Volume 2A-Amphibia & Reptilia, C.J.Glasby, G.J.B.Ross & P.L.Beesley (eds.), pp.58-63. Australian Government Publishing Service. Canberra ACT.

Tyler, M.J., Davies, M. & Martin, A.A. (1981a) New and rediscovered species of frogs from the Derby-Broome Area of Western Australia. Rec.West.Aust.Mus. 9(2): 147-72.

Tyler, M.J., Davies, M. & Martin, A.A. (1981b) Australian frogs of the leptodactylid genus *Uperoleia* Gray. Aust.J.Zool. (Supp. Series) 73: 1-64.

Tyler, M.J. & Davies, M. (1986) Frogs of the Northern Territory. Conservation Commission of the Northern Territory. Alice Springs NT. 77pp.

Valentic, R. (1995) Diurnal basking in the tree frogs *Litoria gilleni* and *Litoria rubella*. Monitor 7(1): 27.

Withers, P.C. (1995) Evaporative water loss and colour change in the Australian desert tree frog *Litoria rubella* (Amphibia: Hylidae). Rec.West.Aust.Mus. 17(3): 277-81.

Withers, P.C., Hillman, S.S. & Drewes, R.C. (1984) Evaporative water loss and skin lipids of anuran amphibians. J.Exp.Zool. 232: 11-7.

FIRST RECORD OF THE MURRAY TURTLE, *EMYDURA MACQUARII* (GRAY) (TESTUDINES: CHELIDAE) FROM THE AUSTRALIAN CAPITAL TERRITORY

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Whilst conducting a fisheries monitoring program on the Murrumbidgee and lower Molonglo Rivers in the Australian Capital Territory (ACT) in November-December, 1994, a single individual of the Murray turtle *Emydura macquarii* was captured in a fyke net. The sampling program involved monitoring of seven sites on the Murrumbidgee River along its length in the ACT and a single site on the lower Molonglo River, approximately one kilometre below the Lower Molonglo Water Quality Control Centre (LMWQCC) (Figure 1)

Sampling equipment at each site consisted of six nylon multi-filament gill nets, each 35 metres long; six single-winged fyke nets (mesh diameter 15 mm); ten bait traps containing chemical light sticks and 50 metres of near-bank electrofishing with a backpack electrofisher. All traps and nets were set between 3.30 and 4.30 pm and retrieved the next day between 6.30 and 8.30 am. Backpack electrofishing was carried out in the early afternoon, usually just prior to setting the other sampling gear.

Gill nets were unweighted and attached to a float line with the drop of each net varying between 33 and 100 meshes deep (depending on the net size). Fyke nets were attached to the bank at the cod-end and then angled downstream with a weight attached to the wing to hold the net securely. Each fyke net had a 150 mm diameter polystyrene float inserted in the cod-end to provide an airspace to prevent mortality of non-target animals.

A total of 31 non-target individuals comprising four species were captured in the sampling program. The non-target species caught were platypus, *Ornithorhynchus anatinus* eastern long-necked turtle, *Chelodina longicollis* maned duck *Chenonetta jubata* and Murray turtle (Table 1). All turtles were caught in the fyke nets. Seven of the nine platypus and the single maned duck were captured in gill nets with the remaining two platypus caught in a fyke net. All were released alive.

The single Murray turtle captured was recorded at Retallacks Hole, the most downstream site sampled (Figure 1). The individual was an adult male with carapace dimensions of 245 x 196 mm.

Table 1. Number of non-target individuals captured.

SITE	Date Sampled	Platypus	Eastern long-necked turtle	Murray turtle	Maned duck
Angle Crossing	29/11/94	2	6	-	-
Tharwa Sandwash	15/11/94	-	4	-	-
Point Hut Crossing	24/11/94	1	1	-	-
Kambah Pool	17/11/94	-	1	-	1
Casuarina Sands	22/11/94	-	-	-	-
Camp Sturt	13/12/94	1	6	-	-
Retallacks Hole	6/12/94	1	1	1	-
Below LMWQCC	8/12/94	4	1	-	-
TOTAL		**9**	**20**	**1**	**1**

This is the first recorded capture of a "wild" individual of this species in the ACT, although there have been several captures in recent years of *E. macquarii* in Canberra's urban lakes, Lake Burley Griffin and Lake Ginninderra. These urban captures are thought to have been illegally released, unwanted pets or escapees. Examination of the carapace of the lakes specimens by Dr Arthur Georges revealed distinctive abnormal growth patterns, characteristic of captive animals.

An examination of the individual from Retallacks Hole did not reveal this abnormal growth pattern, indicating the specimen's "wild" status. The remoteness of the collection locality also suggests a "wild" origin for this animal as unlike Canberra's urban lakes, Retallacks Hole is remote from suburbia, and therefore unlikely to receive a released captive animal.

This record of *E. macquarii* extends the known range of this species in the Murrumbidgee drainage. The nearest known population is in Lake Burrinjuck approximately 45 km downstream of Retallacks Hole (A. Georges pers. comm.) where both hatchling and adult turtles have been collected. Cogger *et al.* (1983) listed the distribution of E. macquarii as including the ACT but this is thought to refer to escapes from captivity as "wild" specimens were unknown in the ACT prior to the current record.

E. macquarii is usually found in the lower reaches and floodplain habitats of the Murray-Darling basin (Cogger 1992; Chessman 1986; Goode 1967; Cann 1978). In the Murray valley, *E. macquarii* prefer the deep, slow flowing stretches of the main river channel and the deep backwaters and billabongs adjacent to the river (Legler & Georges 1993; Chessman 1988). The Murrumbidgee River in and upstream of the ACT is noticeably different to the usual habitats of *E. macquarii* in that the river has a steeper gradient and faster flow, is shallower, and has no significant floodplain or billabong development. The altitude of Retallacks Hole is approximately 420 m ASL which may be approaching the upper altitudinal limit of *E. macquarii* in the Murrumbidgee River system. Knowledge of the upper altitudinal limits of *E. macquarii* and the environmental conditions that prevail there (especially temperature) may be important in modelling the former distribution of this species during the glacials.

This upper altitudinal limit is in contrast with that for *Chelodina longicollis* which breeds throughout the Murrumbidgee River in the ACT and has been recorded at two sites at approximately 1100 m (Lintermans 1993, Lintermans & Ingwersen 1996). Breeding populations of *C. longicollis* can be found at altitudes circa 800 m in the Cooma district (A. Georges pers. comm.) which is consistent with the findings of Chessman(1978) which showed this species to be more tolerant physiologically of cold conditions than *E. macquarii*.

REFERENCES

Cann, J. (1978). Tortoises of Australia. Angus & Robertson.

Chessman, B.C. (1978). Ecological studies of freshwater turtles in south-eastern Australia. Unpublished Ph D Thesis, Monash University.

Chessman, B.C. (1986). Diet of the Murray turtle, *Emydura macquarii* (Gray) (Testudines : Chelidae). Aust. Wildl. Res. 13(1): 65-69.

Chessman, B.C. (1988). Habitat preferences of freshwater turtles in the Murray valley, Victoria and New South Wales. Aust. Wildl. Res. 15(5): 485-491.

Cogger, H. G. (1992). Reptiles and Amphibians of Australia. Fifth edition, Reed.

Cogger, H. G., Cameron, E. E. & Cogger, H. M. (1983). Zoological Catalogue of Australia. Vol: 1 Amphibia and Reptilia. Australian Government Publishing Service, Canberra.

Goode, J. (1967). Freshwater Tortoises of Australia and New Guinea. Lansdowne Press, Melbourne.

Legler, J. M. & Georges, A. (1993). Family Chelida. Pp 142-152 Glasby, C. J., Ross, G. J. B. & Beesley, P. L. (eds.) Fauna of Australia. Vol. 2A Amphibia & Reptilia. Australian Government Publishing Service, Canberra.

Lintermans, M. (1993). The vertebrate fauna of the Gudgenby region of the Australian Capital Territory: A review. Technical Report 1, ACT Parks and Conservation Service, Canberra.

Lintermans, M. and Ingwersen, F. (1996). Important wetlands of the Australian Capital Territory. Pp 31-46 in Australian Nature Conservation Agency (1996) A Directory of Important Wetlands in Australia Second Edition. ANCA, Canberra.

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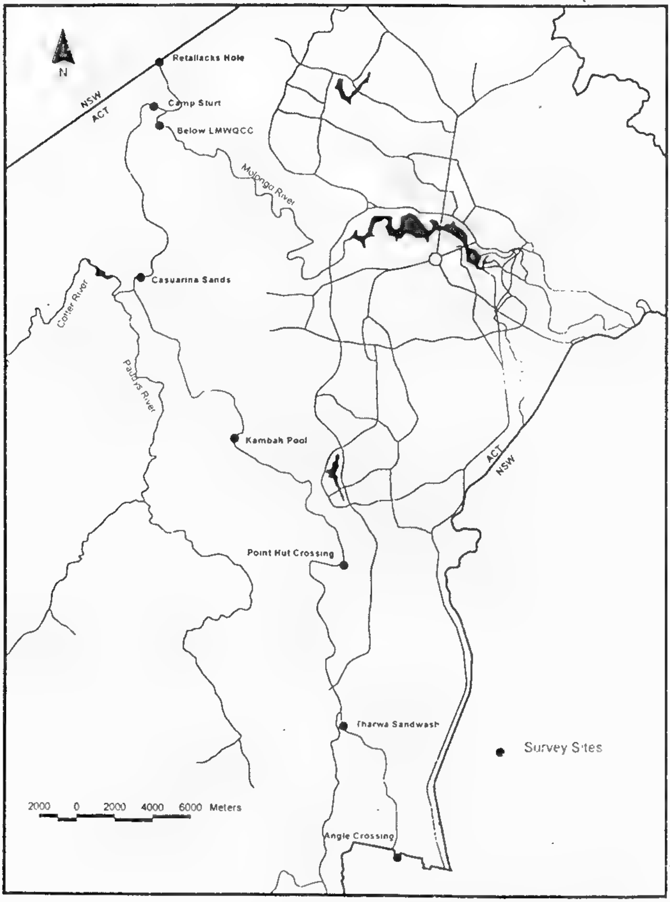
Figure 1. The Murrimbidgee and Molonglo Rivers in the ACT showing sites surveyed in November-December 1994.



OBSERVATIONS ON SOME REPTILES FROM MINNIE WATER, NORTH-EASTERN NEW SOUTH WALES

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This paper presents observations on some reptile species from a one kilometre radius centred on the general store at Minnie Water (29°46'S, 153°18'E), north-eastern New South Wales between 3 June 1995 and 26 March 1996. The town of Minnie Water is fringed on the landward side by Yuryagir National Park and the coastal waters and intertidal shoreline are included in the Solitary Islands Marine Reserve. All observations outlined were the result of incidental encounters while living at Minnie Water.

OBSERVATIONS

Green Turtle *Chelonia mydas*

Llewellyn et al. (1994) listed few localities for this species in New South Wales. However, *C.mydas* is regularly observed off Byron Bay and in the Ballina area (D. Charley, NSW National Parks and Wildlife Service, M. Schulz, unpubl. records). The southernmost breeding record for this species in New South Wales occurred during the summer of 1995-96 at Corindi Beach, 30 km south of Minnie Water (L. Hardman, pers. comm.). Three individuals were encountered on separate occasions while snorkelling off the outer reef platforms between 26 January and 18 March 1996. The surface water temperature at the time of these sightings varied between 26-27°C.

In addition, a number of unidentified turtles, suspected to be *C.mydas*, were seen swimming off the outer reef platforms and in more protected waters from 31 December 1996 to 26 March 1996. Most of these sightings were of single individuals; however, on 31 January 1996 three small individuals were observed. On this occasion, the sea temperature was 29°C, which is unusually high for waters off Minnie Water (G. Biddle, long-time resident, pers. comm.). No turtles were observed between June and December.

Land Mullet *Egernia major*

E.major is typically regarded as a species that occurs in rainforest and adjacent wet sclerophyll forest (Cogger 1994, Swan 1990, Wilson and Knowles 1988). At Minnie Water, this species is moderately common in coastal heath, particularly heath communities with a variable Coast Banksia Banksia integrifolia overstorey and patches of dense Bitou Bush shrub layer. At least one adult also lived in our backyard under a pile of stacked corrugated iron sheeting with little vegetation for over 70m, other than mowed grass and scattered Banksias and eucalypts. The presence of *E.major* in such vegetation types is at variance to the generally accepted habitats of this lizard (see above references).

G. Biddle (pers. comm.) observed that in the past this species was not present in the area, but was known from denser forest habitat some 18 km ENE in the Pillar Valley area. During the 1970s when the Bitou Bush spread densely throughout many parts of the foreshore reserve *E.major* suddenly appeared. Similarly, at Diggers Camp, a small settlement 5 km south of Minnie Water the appearance of *E.major* coincided with the local increase of Bitou bush (K. Goodrich, former local resident, pers. comm., M. Schulz unpubl. records). This evidence suggests that the presence of this species at Minnie Water and also Diggers Camp is associated with the establishment of extensive dense stands of the noxious Bitou Bush.

Individuals were commonly observed feeding on fungus, some of which was dug up, particularly from under shaded stands of Bitou Bush. The individual living in our backyard was also seen raiding the compost, feeding on over ripe fruit. Wilson and Knowles (1988) noted that plant material such as fungi and fallen fruits constitute a significant component of this species' diet.

Grass Skink *Lampropholis delicata*

L.delicata is normally regarded as a diurnal species (e.g. Swan 1990). However, on the majority of warm nights between November and March individuals were commonly encountered active in the outbuildings and around the house to the early hours of the morning.

Blind Snake *Ramphotyphlops nigrescens*

On 3 January 1996 a male (total length: 21 cm) was found dead on the beach below the high tide mark. This finding followed a period of heavy, prolonged rain and strong onshore winds. It is possible that this individual had been dislodged from the primary dune face, which on the previous high tide had been cut away by the large onshore swell. The primary dunes in this locality were a narrow eroding band, sparsely vegetated by Spinifex *Spinifex hirsutus* and backed by coastal heath with a dense Bitou Bush shrub layer.

Carpet Snake *Morelia spilota*

A small individual (approx. 1.5m total length) was observed in the process of swallowing an immature Buff-banded Rail *Gallirallus philippensis* on 14 March 1996. The Buff-banded Rail is a common species in areas of dense sedgeland and heathland around Minnie Water.

A moulting individual was located amongst the foliage of a Pandanus 5m above the ground on the edge of the beach on 28 January 1996.

Sea Snake spp.

No beachwashed sea snakes were located during the observation period. On two occasions (30 December 1995 and 31 January 1996) single unidentified sea snakes were observed surfacing briefly off the outer reef platforms in a water depth of 10+m. The second sighting was on the same afternoon that three turtles (possibly *C.mydas*, see above) were observed when the sea temperature was unusually high. Both sea snakes were approximately 1m in total length, dark above with lighter variegations and blotching. However, neither individual was seen for long or clear enough to record a detailed description to enable species identification. The size and lack of unique colour pattern indicated that these individuals were not the Yellow-bellied Sea Snake *Pelamis platurus*. Llewellyn et al (1994) listed three species for New South Wales: *Astrotia stokesii*, *Hydrophis elegans* and *P. platurus*.

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REFERENCES

Cogger, H.G. (1994). Reptiles and amphibians of Australia. Reed, Sydney.

Llewellyn, L., Ellis, M., Martin, J. and Ferguson, A. (1994). Atlas of New South Wales wildlife: marine mammals and reptiles. NSW National Parks and Wildlife Service, Sydney.

Swan, G. (1990). A field guide to the snakes and lizards of New South Wales. Three Sisters Publications, Winmalee.

Wilson, S.K. and Knowles, D.G. (1988). Australia's reptiles: a photographic reference to the terrestrial reptiles of Australia. Collins, Sydney.

RECENT RECORDS OF THE SOUTHERN BARRED FROG (*MIXOPHYES BALBUS*) FROM THE SOUTH COAST OF NSW

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The Southern barred frog, *Mixophyes balbus*, is a large (up to 80mm), terrestrial frog found in forests of the coast and adjacent ranges from the Gippsland area of Victoria to the Gibraltar Range in northern NSW. It is the most southerly of the six species within the genus (Cogger, 1992) and all are referred to as barred frogs due to the distinctive striping found on their back legs.

This species is known to have suffered a decline in recent times populations from the area immediately north of Sydney being recorded as having disappeared (Mahony, 1993). Perhaps of greater concern has been the fact that there are no published records of this species from the south coast of NSW since the early 1980's (see Lunney and Barker, 1986 and Webb, 1991) and recent surveys in Victoria had failed to locate any individuals (G.Gillespie, pers. comm.), a situation which has raised concerns over the status of this species in the southern part of its range. We report here the following recent sightings of this species which reaffirm the presence of this species on the NSW south coast:

a) On the night of the 16th of February 1994, Belimba Creek in Dampier State Forest (AMG 754050 6005350) was surveyed for frogs by staff from the Narooma Office of the State Forests of NSW (SFNSW). Upon playing the call of the Southern barred frog a response was heard from vegetation on the bank of the stream some five metres from the edge of the water. Continued playbacks resulted in regular responses by the individual, but attempts to locate this frog were unsuccessful (the male was probably calling from within a burrow). A later daylight inspection of the site revealed it to represent habitat typical for this species (F.Lemckert, pers. obs.) being a clear, flowing permanent stream in wet sclerophyll forest dominated by river peppermint (*Eucalyptus elata*) with a grey myrtle (*Backhousia myrtifolia*) and soft tree fern (*Dicksonia antarctica*) understorey and sparse ground cover.

b) In October 1994, Steven Westaway (a logging contractor) located a large frog sitting on the ground during a logging operation in Mumbulla State Forest (AMG 761800 5948600). This frog was picked up and examined by Mr. Westaway who described it as approximately 7cm in body length, brown in colouration and with conspicuous black stripes on its hind legs. It was the latter point which was of specific interest to the contractor as he had not previously seen a frog with this type of marking. The surrounding vegetation was wet sclerophyll forest dominated by yellow stringybark (*Eucalyptus muelleriana*) with a moderately dense understorey of *Allocasuarina* sp. and a grassy ground cover dominated by forest wire grass (*Tetrarrhena juncea*). The frog showed no signs of injury and it appears likely that the frog had been disturbed by the activity and had moved from its daily shelter site at the time of its discovery. An aural (including call play-back) and visual search of the general area in February failed to detect any calling or foraging individuals.

c) A return survey to the general area of the first record was carried out by two of us (B.S. and T.B.) on the evening of the 15th of February 1995. During this survey no responses were obtained to call playbacks, but a single individual of *Mixophyes balbus* was captured. This frog was located on the forest floor 2m from the edge of the water and 400m downstream of the initial record site. This frog was returned to the Narooma Office and photographs taken to provide confirmation of its

identity (see Figure 1). This individual was 68.5mm body length and appeared to be male as there was some darkening of the throat region, although there were no indications of nuptial pad development (Figure 1). This frog was released at the site of capture two days later.

During February 1995 several surveys were also conducted in Mumbulla State Forest. On the night of the 22nd of February, a response to a call playback was obtained by Allan Douch and Paul McGrath (Narooma District SFNSW) on Knights Creek, some 4.5km from the 1994 record (AMG 765000 5949900). Repeated playbacks obtained one further response, but the frog was not located. At this site Knights Creek is a broad, gravel bottomed creek with scattered pools. The forest is wet sclerophyll dominated by mountain grey gum (*Eucalyptus cypellocarpa*) with a dense understorey and ground cover dominated by mint bush (*Prostanthera violaceae*) and mat rush (*Lomandra* sp.).

The habitats in which these records were made (clear, permanently flowing streams in moist forest) are typical of those recorded for the species by Cogger (1992) and in accordance with the observations of Lunney and Barker (1986) and Webb (1991). Of interest was the timing of the calling activity of the males. The reproductive season of this species in the southern part of its range remains uncertain (Brook, 1980; Hero et al., 1991), but males of this species were only heard calling in February even though surveys were conducted during suitable conditions (post-rainfall) in November 1994 and January 1995. This suggests that February may be the most active breeding period for this species in the southern part of its range. More information is required on the calling and breeding season of *M. balbus* in the region to ensure that future surveys for this species (which tend to rely on call identification) can be performed at times which provide the optimum chance for success.

It also remains possible that the apparent rarity of this species on the south coast of NSW may be at least partly the result of limited survey effort in this region. No significant frog surveys appear to have been undertaken in the region between the early 1980's and 1993, the time period over which there are no records of the frog. However, in the last year additional sightings of this species have been made in the Helensburgh and Nowra areas of N.S.W. (G. Daly, pers. comm.), both after more intensive surveys were performed. Although these records appear to be for only a very few individuals, it suggests that this species may yet prove to be more widespread than currently thought, especially as its soft call and secretive nature make it a difficult frog to locate.

Clearly there is an urgent need for further detailed survey work to establish more precisely the status and current distribution of *M.balbus* south of Sydney. Furthermore, work is required to determine what role, if any, forestry activities have played in the apparent decline in abundance of this species within the region. Only with such information can an effective conservation plan be developed for the species in southern N.S.W.

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REFERENCES

Brook, A.J. (1980). The breeding season of frogs in Victoria and Tasmania. Vic. Nat. 97; 6-11.

Cogger, H.G. (1992). Reptiles and Amphibians of Australia. Reed Book, Sydney.

Hero, J.M., Littlejohn M.J. and Marantelli, G. (1991). Frogwatch Field

Guide to Victorian Frogs. Victorian Department of Conservation and Land Management, East Melbourne.

Lunney, D. and Barker, J. (1986). Survey of reptiles and amphibians of the coastal forests near Bega, N.S.W. Aust. Zool. 22 (3); 1-7.

Mahony, M.J. (1993). The status of frogs in the Watagan Mountains area of the Central Coast of New South Wales. Pp 257-264 in D. Lunney and D.Ayers (eds.) Herpetology in Australia: A Diverse Discipline. Surrey Beatty and Sons with R. Zool. Soc. N.S.W., Sydney.

Webb, G.A. (1991). A survey of the reptiles and amphibians of Bondi State Forest and surrounding areas, near Bombala, New South Wales. Aust. Zool. 27 (1&2): 14-19

Figure 1. Two views of the Southern barred frog collected in Dampier State Forest. (Photos: M. Potter)

LOCAL SYMPTOMS OF ENVENOMATION BY THE ORNAMENTAL SNAKE, *DENISONIA MACULATA* (STEINDACHNER): ELAPIDAE

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The Ornamental snake (*Denisonia maculata*) is a venomous snake limited to the Dawson River catchment in central eastern Queensland (Covacevich and Couper 1991, Cogger 1992). It is nocturnal, and preys mostly on frogs (Shine 1983). *D.maculata* has been given a conservation status of 'vulnerable' by McDonald et al. (1991) and Cogger et al. (1993). Ehmann (1992) describes *D.maculata* as consisting of sparse populations, but that its conservation status is 'probably secure'.

Because of its limited geographic distribution, small size (mean snout-vent length: 283-335 mm, Shine 1983), secretive habits, and the possible small size of *D.maculata* populations, the Ornamental snake is rarely encountered in the field and bites from this species are apparently rare. There are no confirmed records of *D.maculata* snake-bite cases at Rockhampton Base Hospital (H. Hunt pers. comm.) or at Mackay Base Hospital (B. Sadleir, pers. comm.). However, recently a patient presented at Mackay Base Hospital who had been bitten on the dorsum of the foot by a snake which approximately fitted the description of *D.maculata*. The patient experienced local bruising and swelling around the bite site as well as signs of inguinal lympthadenopathy and mild consumptive coagulopathy, but did not experience any systemic symptoms and was discharged the next day (B. Sadleir, pers. comm.).

An extensive search of the literature failed to locate any published confirmed cases of envenomation by *D.maculata*. Published accounts of the envenomation of humans by *Denisonia* are infrequent. Kinghorn (1956) reports that the bite of D.maculata is not dangerous to humans, although the venom can cause paralysis in small animals, but with a rapid return to normal. Worrell (1963) describes a case where a male snake-handler lost consciousness following a bite from *D.maculata*. Kellaway (cited in Worrell 1963) describes the bite of *D.maculata* as having characteristic effects, rapid onset of paralysis and coma, with an abrupt return to normal. Both Kinghorn (1956) and Worrell (1963) were probably referring to Kellaway's (1934) study. However, Kellaway's studies of envenomation by *D.maculata* are now thought to have been conducted on *D.devisii* (Sutherland 1983). Coventry (in Sutherland 1983) describes a case of envenomation by *D.devisii* in which the patient became cyanosed and lost consciousness for 30 minutes, after which the patient rapidly recovered although the bite site remained painful for days. Cogger (1992) describes the bite of *D.maculata* as potentially dangerous and suggests that bites from this species be treated seriously. Although the biochemical and toxicological effects of the venom of larger Australian elapid snakes are well known (see White 1987a, b for reviews), there are few studies of the biochemical effects of the venom of small elapids such as *D.maculata*.

Because of the lack of published confirmed accounts of snakebite by *D.maculata* and the lack of information on the biochemical and pharmacological effects of venoms of small elapid snakes, the comparative toxicity of the bite of small elapids is difficult to estimate. Also, cases of mild, local effects of envenomation are almost certainly under-represented in the literature when compared to cases in which symptoms are more severe. The reporting of cases in which no severe systemic symptoms are observed may allow a more realistic assessment of the hazard that a bite from an elapid snake may provide. In this note I describe the symptoms of envenomation of the author by *D.maculata*.

On the evening of 24 April 1996 the author (male, 64 kg, age 29 yrs, in good health) was bitten on the proximal joint of the left ring finger by an Ornamental snake (female, SVL = 247 mm, mass = 8 g, Queensland Museum registration number J61710) at Hail Creek, near Nebo (21°28′66′S, 148°23′55′). The bite was mildly painful, similar in intensity to a bee sting, but the pain quickly subsided. Two fang marks were clearly visible at the site of envenomation. Redness and swelling of the bite site was visible after a few minutes, together with some stiffening of the joint. First aid (application of a constrictive bandage to the entire limb, avoidance of unnecessary movement) was applied approximately 30 minutes after the time of envenomation, following an 800 m walk. No systemic symptoms were experienced at any time. Medical assistance was not sought. The constrictive bandage was kept in place until 5.45 am the next day. By this time, swelling had mostly subsided although there was some residual soreness at the bite site and some slight swelling and stiffness of the left hand middle finger. Mild soreness persisted at the bite site for approximately seven days.

This account of envenomation by *D.maculata* shows that mild, localised effects may occur without the onset of acute, systemic symptoms. However, as no medical assessment was obtained, it cannot be reliably stated that there was an absence of either signs of envenomation or laboratory evidence of envenomation.

Given that the few published accounts of envenomation by *Denisonia* describe significant systemic symptoms, why were only localised effects experienced in this case? Several hypotheses may provide an explanation: The two published accounts may have exaggerated the effects of *Denisonia* envenomation since both cases were of bites to professional herpetologists who had been previously bitten by other snake species and who may have been sensitised to snake venom. Kellaway (1934) pointed out that the patient he described may have suffered an anaphylactic reaction as that patient was known to be sensitised to snake venom. However, Sutherland (1983) notes that Coventry's description of the delay of one hour between the bite and the collapse of the patient is more consistent with the direct effects of the toxicity of the venom, rather than an allergic response. Therefore, although an allergic response cannot be ruled out, this hypothesis seems unlikely.

There may also be interspecific variation in toxicity between *D.devisii* and *D.maculata*, but at present there have been too few confirmed cases of envenomation by either species, and no laboratory studies to allow the assessment of this possibility.

The most likely hypothesis is that only a small amount of venom may have been injected at the bite site, perhaps due to the small size of the specimen or the difficulty of injecting venom into the finger joint. Application of first aid may have also slowed the spread of venom through the body, allowing time for some venom immobilisation or destruction at the bite site. Despite the apparent variability and uncertainty in the symptoms of *D.maculata* envenomation, bites from this species should probably still be treated seriously and correct first aid procedures should be applied (Sutherland et al 1979, Sutherland 1994). Specimens should be handled with extreme caution. More studies of the venom of both *Denisonia* species would be of medical and scientific interest.

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REFERENCES

Cogger, H., Cameron, E., Sadleir, R. and Eggler, P. (1993). The action plan for Australian reptiles. Australian Nature Conservation Agency: Canberra, 254 pp.

Covacevich, J.A. and Couper, P.J. (1991). The reptile records. In Ingram, G.J. and Raven, R.J. (eds.) 'An Atlas of Queensland's Frogs, Reptiles, Birds & Mammals'. Board of Trustees of the Queensland Museum, Brisbane. pp. 16-44.

Ehmann, H. (1992). Encyclopedia of Australian Animals. Vol. 3. Reptiles. R. Strahan (ed.) Angus and Robertson, Pymble, NSW.

Kellaway, C.H. (1934). The venom of the ornamented snake *Denisonia maculata*. Aust. J. Exp. Biol. Med. Sci. 12: 47-54.

Kinghorn, J.R. (1956). The snakes of Australia. Angus and Robertson Ltd, Sydney, 197 pp.

McDonald, K.R., Covacevich, J.A., Ingram, G.J. and Couper, P.J. (1991). The status of frogs and reptiles. In Ingram, G.J. and Raven, R.J. (eds). 'An Atlas of Queensland's Frogs, Reptiles, Birds & Mammals'. Board of Trustees of the Queensland Museum, Brisbane. pp. 338-345.

Shine, R. (1983). Food habits and reproductive biology of Australian elapid snakes of the genus *Denisonia*. J.Herp. 17(2): 171-175.

Sutherland, S.K. (1983). Australian animal toxins. The creatures, their toxins and care of the poisoned patient. Oxford University Press, Melbourne, 527 pp.

Sutherland, S.K. (1994). Venomous creatures of Australia. A field guide with notes on first aid. Oxford University Press, Melbourne, 128 pp.

Sutherland, S.K., Coulter, A.R. and Harris R.D. (1979). Rationalisation of first aid measures for elapid snakebite. Lancet 1 (8109): 183-185.

White, J. (1987a). Elapid snakes: venom toxicity and action. In Covacevich, J., Davie, P., Pearn, J. (eds). 'Toxic plants and animals. A guide for Australia'. Queensland Museum, Brisbane. pp. 369-389.

White, J. (1987b). Elapid snakes: aspects of envenomation. In Covacevich, J., Davie, P., Pearn, J. (eds). 'Toxic plants and animals. A guide for Australia'. Queensland Museum, Brisbane. pp.391-429

Worrell, E. (1963). Reptiles of Australia. Angus and Robertson Ltd, Sydney, 207 pp.

HERPETOLOGICAL NOTES

PREDATION ON *LITORIA TORNIERI* (ANURA: HYLIDAE) BY A *DOLOMEDES* LIKE SPIDER (ARANEOMORPHAE: PISAURIDAE)

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INTRODUCTION

While anecdotal accounts exist, well documented cases of invertebrates preying on reptiles and frogs in Australia are few. The common and scientific names of spiders mentioned below follow Main (1984). The Sydney funnel-web spider *Atrax robustus* and brush-footed trapdoor spiders (*Barychelidae*) have been documented preying upon frogs (Brunet, 1994). A photo depicting a barking spider *Selenocosmia* sp. preying on *Litoria leseuri* appeared in 'Australia's Dangerous Creatures' (Underhill, 1993). Mascord (1993) wrote of an adult female *Selenocosmia crassipes* that killed and ate a young *Litoria caerulea* in 6 hours. Main (1984) also lists examples of spiders eating frogs. Orange (1990) recorded a redback spider *Latrodectus mactans* preying upon *Suta monachus,* a small elapid species. Two other references relating to spider predation on snakes are also cited in the paper. Danny Goodwin (pers. comm. 1996) has noted several cases of *Latrodectus* sp. preying on weasel skinks *Saproscincus mustelinus.* A large species of preying mantid *Hierodula werneri* has also been observed catching frogs at Darwin (Ridpath, 1977). Nash (1963) refers to a large brown mantid consuming a juvenile *Litoria raniformis* (referred to as a golden bell frog). Nursery-web spiders *Dolomedes* spp. 'capture tiny fish, tadpoles, insects and skinks' (Brunet, 1994; McKeown, 1943).

The following note records a large female *Dolomedes* like spider (the spider was not reliably identified as a *Dolomedes* sp., as opposed to *Megadolomedes* for example, and is thus referred to as 'a *Dolomedes* like spider' in this note) subduing and feeding on an adult *Litoria tornieri* at Edith Falls in the north-west section of Nitmiluk (Katherine Gorge), National Park, Northern Territory (14°11'S, 132°11'E).

OBSERVATION

Date: 10 November 1991

Time: 20:15 hours (Central Standard Time)

Weather conditions:
Full moon, clear night, (air temp. of 26°C with high relative humidity)

Habitat: The embankment of a large plunge-pool of the Edith River system. Riparian flora consisting predominantly of Pandanus and Melaleuca. Understorey essentially bare and covered by a thick layer of leaf litter.

Notes: Whilst searching for frogs by torch-light a loud disturbance amongst leaf litter some two metres from the river edge was noted. Upon investigation a frog was observed leaping awkwardly as though impeded. On closer inspection a large *Dolomedes* like spider was discovered straddled atop the frog's dorsum, its long limbs wrapped tightly around and completely enveloping the prey. The spider's *chelicerae* were pressed firmly into the frog's neck region. The frog, which constantly jumped in a limited area (1m≤), was identified as *L.tornieri*. The spider appeared undeterred by these attempts to remove it and maintained a strong grasp. After ten minutes (20:25 hours), the *L.tornieri* appeared dead and the spider began feeding by raising and subsequently lowering the fangs into the frog's anterior half. Throughout the observation the long legs remained tightly wrapped around the frog. At 22:25 hours the site was again inspected although no sign of prey or predator could be located.

DISCUSSION

The frog did not emit a distress call during the above encounter. Nash (1963) refers to the distress call of a young *Litoria raniformis* which was being consumed by a mantid. Perhaps *L.tornieri* are incapable of a distress call or vocalisation is restricted to males of this species. The gender of the above *L.tornieri* was not determined during the interaction. Brunet (1994) states that *Dolomedes* typically capture prey within water where the prey is subdued and dragged to the water's edge and devoured. *L.tornieri* are abundant in the leaf litter beneath Pandanus at the site (pers. obs.). It is possible that the spider may have ambushed the frog on land given the distance from the water that the above encounter occurred. The spider may have dragged the frog away from the site to continue feeding referring to the 6 hour consumption span noted by Mascord (1993). Mascord wrote: "All that remained of the frog in that time was a ball of debris 2 cm in diameter which contained bones and skin in a mushy state". A number of small frog species that are common at this site such as *Litoria bicolor, L.meiriana, L.rubella* and *Limnodynastes ornatus* (pers. obs.) may also be considered potential prey for *Dolomedes* like spiders.

ACKNOWLEDGEMENTS

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REFERENCES

Brunet, B.S. (1994). The Silken Web - A Natural History of Australian Spiders. Reed Books, Chatswood, NSW. 208pp.

Main, B.Y. (1984). Spiders. Collins Books, Sydney, NSW. 296pp.

Mascord, R. (1993). Australian Spiders in Colour. Reed Books, Chatswood, NSW. 112pp.

McKeown, K.C. (1943). Vertebrates captured by Australian spiders. Proceedings of the Royal Zoological Society of NSW. 1942-1943: 17-30.

Nash, K.M. (1963). Along the By-ways (Letters to the Editor). The Victorian Naturalist. 79(1):11.

Orange, P. (1990). Predation on *Rhinoplocephalus monachus* (Serpentes: Elapidae) by the Redback spider *Latrodectus mactans*. Herpetofauna. 20(1):33.

Underhill, D. (1993). Australia's Dangerous Creatures. Reader's Digest, Surry Hills, NSW. 368pp.

Ridpath, M.G. (1977). Predation on frogs and small birds by *Hierodula Werneri* (Giglio - Toss) (Mantidae) in tropical Australia. Journal of the Australian Entomological Society. 16:153-154.

AN OBSERVATION OF COLD-TOLERANT ACTIVITY IN THE LEAF-TAILED GECKO SPECIES *SALTUARIUS SWAINI*

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On the 11th December 1993 one night was spent attempting to fulfil a collection permit for two adult pairs of the leaf-tailed gecko *Saltuarius swaini,* near Giraween National Park, southern Queensland. This area is well known for its extreme winter temperatures, often well below freezing. Even in early summer, night temperatures plummet rapidly after dusk. At the time searching commenced, around 1930 hours, the air temperature was recorded at approximately 16°C. Over the following four hours eight specimens of *S.swaini* were located, seven males and one female.

At 2345 hours one specimen was observed approximately five metres high on the side wall of a narrow steeply sloping rock chimney. After much difficulty the chimney was scaled, only to find the lizard had retreated into an inaccessible crevice. After descent from the chimney an air temperature reading was taken as 10.5°C. Further areas were then searched around the vicinity with no success. On checking the same chimney some fifteen minutes later the gecko was observed again in exactly the same position. The rock was scaled and this time the animal was captured. It proved to be another male.

There are few reports of lizard activity below 15°C. Heatwole and Taylor (1987) record a range of voluntary minimum temperatures (i.e. that at which the reptile seeks shelter), the lowest being 13.3°C for the skink *Eulamprus tenuis* (as *Sphenomorphus tenuis*).

Heatwole and Pianka (1993) illustrate mean body temperatures of field active lizards, which indicates the family Gekkonidae are mostly active at lower body temperatures than three other Australian lizard families. Henle (1990) reports the lower limits of air and substrate temperature for *Lucasium damaeum* (as *Diplodactylus dameaus*) and *Diplodactylus tessellatus* at 7.9°C and 12.7°C respectively. Werner and Whitaker (1978) recorded activity in the New Zealand gecko *Hoplodactylus maculatus* at body temperatures as low as 10°C, while Dawbin (1962) observed the same species active in air temperatures of 8°C. Brain (1962) noted activity in the African desert geckos *Ptenopus carpi* and *P.garrulus* at body temperatures of 10.2°C and 11.6°C respectively.

Clearly there are few reports concerning gekkonid activity at low temperatures comparable to the current observation. It is particularly interesting that this specimen was evidently far from its voluntary minimum, as indicated by its reappearance only a short time after disturbance. This may suggest a voluntary minimum perhaps several degrees lower than the current observation, approaching the lowest record for an Australian lizard. Such a record, however, is still much higher than that reported by Burrage (1973), who suggested that the chameleon *Chameleo namaquensis* may catch flying insects before dawn, when air temperatures were as low as 3.5°C!

Literature Cited

Brain, C.K., 1962. Observations on the temperature tolerance of lizards in the central Namib Desert, South West Africa. Cimbebasia 4: 1-5.

Burrage, B.R., 1973. Comparative ecology and behaviour of *Chameleo pumilus pumilus* (Gmelin) and *C.namaquensis* A. Smith (*Sauria: Chamaeleontidae*). Ann.S.Afr.Mus.:1-158.

Dawbin, W.H., 1962. The tuatara in its natural habitat. Endeavour 2: 16-24.

Heatwole, H. and Pianka, E.R., 1993. Natural History of the squamata. Pp 197-209 in Glasby, C.J., Ross, G.J.B. and Beesley, P.L. (eds). Fauna of Australia. Vol. 2A. Amphibia and Reptilia. Australian Government Publishing Service, Canberra.

Heatwole, H.P. and Taylor, J., 1987. Ecology of Reptiles. Surrey Beatty and Sons, Sydney.

Henle, K., 1990. Population ecology and life history of three terrestrial geckos in arid Australia. Copeia 1990: 757-781.

Werner, Y.L. and Whitaker, A.H., 1978. Observations and comments on the body temperatures of some New Zealand reptiles. NZ Jl. Zool. 5:375-393.

OBITUARY: CHARLES TANNER, HERPETOLOGIST

(Reprinted from the Memoirs of the Queensland Museum 42(1):377-78. 1997).

Conversations with herpetologists suggest that some of us are "born" and some are "made". Charles Tanner (born 19 January, 1911, Brighton, England; died 23 December, 1996, Cairns, Australia) was definitely one of the former. Amongst his earliest memories were those of days spent "haunting" the reptile house of London Zoo. Wherever he was - the United Kingdom, Iraq (Abadan), Palestine, Cyprus, the United States of America, Papua New Guinea, or Australia (from Tasmania to Cape York and Byron Bay to Carnarvon) - he observed, admired, photographed and collected reptiles, and wrote and talked about them. They were a life-long obsession.

Charles Tanner's contributions to knowledge of Australia's reptiles were substantial. He had long affiliations with the Museum of Victoria, Melbourne, and the Queensland Museum, Brisbane. He was an Honorary Associate of the former from 1953 until his death. His collections for that museum included 522 frog and 573 reptile specimens. Many of these were collected on his annual leave. Each year, for many years, he and one of us (AJC) travelled to herpetologically unknown or poorly known sites, Australia-wide. His knowledge of, and enthusiasm for finding frogs and reptiles was a never-ending source of astonishment. In 1955, he and Charles Brazenor (then Director of the MOV), collected the first specimens of *Philoria frosti* Spencer 1901 (a rare frog, narrowly confined to Mt Baw Baw, Victoria) seen since collection of the holotype of the species. On New Year Island, Bass Strait, in 1953 and 1954, he photographed Black Tiger Snake, *Notechis ater*, and Shearwater, *Puffinus tenuirostris* interactions. Only one of these photographs has been published (Worrell, 1963). The remainder are now part of his estate, hopefully to be lodged in a museum for posterity.

His association with the Queensland Museum began in 1968. His last donations were made in 1990. Between 1968 and 1990, Charles Tanner donated 302 frog, 548 reptile and 42 mammal specimens to the Queensland Museum. Amongst them are type specimens on which descriptions of many new species were based: *Cophixalus saxatilis* Zweifel & Parker, 1977; *Carlia dogare* Covacevich & Ingram, 1975; *C.jarnoldae* Covacevich & Ingram, 1975; *C.scirtetis* Ingram & Covacevich, 1980; *Ctenotus astarte* Czechura, 1986; *C.nullum* Ingram & Czechura, 1990; *Cryptoblepharus fuhni*, Ingram & Covacevich, 1978; *Lerista ingrami* Storr, 1991; and *Leggadina lakedownensis* Watts, 1976 (possibly a junior synonym of *L.forresti*). Tanner's special interests lay not in description and nomenclature, which he was content to leave to others, but discovering new taxa. Recognition of a new species, collection of specimens, their careful preservation and lodgment in a museum were the parts of a taxonomist's job that he relished. Through this, he encouraged the work and careers of several taxonomists.

Elapids dominated Tanner's research interests and, to a certain extent, his life. For many years he kept a wide-range of species as treasured "pets". Between the early 1960's and 1985, he "milked" specimens in his collection daily on behalf of the Commonwealth Serum Laboratories (now CSL Ltd) Melbourne, the sole producer of antivenoms in Australia. From his dried venom supplies was made much of the antivenom produced in Australia. Many of the survivors of potentially life-threatening envenomations in Tanner's "production time" owe their lives, in no small part, to work conducted at his snake farm-laboratory near Cooktown. His venoms were always the highest quality and were used also in many research projects. His collaborations with Allen Broad of CSL were especially rewarding. The most exciting venom studied was that of *Oxyuranus microlepidotus*.

In 1979 this venom was shown to be the most toxic snake venom in the world. Further investigations showed that it was neutralised effectively by existing Taipan (*Oxyuranus scutellatus*) anti-venom (Sutherland et al., 1978 ; Broad et al., 1979a.b). Venoms collected by Charles Tanner now form a valuable part of the National Collection of Venoms held by the Ausltralian Venom Research Unit of the Department of Pharmacology, The University of Melbourne.

Many of his captive snakes had long and very productive lives in and, sometimes, on! his hands. Tanner survived many life-threatening bites. About them he was reluctant to talk, unlike many victims of snakebite (Pearn; 1990; Pearn et al, 1994). He invariably regarded herpetologists bitten as silly, not brave. "Aggression is not a word I would apply to any snake...", he would say. In 1979, following massive envenomation by a Taipan (*Oxyuranus scutellatus*), Tanner was fortunate to receive the full premedication recommended by CSL. The infusion of antivenom was uneventful and the patient described as miraculous the return of strength to his limbs and the disappearance of his severe headache. "Like mother's milk" was his description of his therapy. Steroid therapy followed for the next four days, because of his special vulnerability to delayed serum sickness. Tanner recovered uneventfully. Charles Tanner's expert elapid husbandry involved the design and development of several "safe" methods and tools of trade; all of which are still in use by those who follow him. Amongst these are the "potato-masher" jigger and the hoop-bags of plastic and calico for "tailing" specimens of several species, including Taipans; hide boxes with trap doors; and use of the strong, opaque plastic bag from which the largest elapid could be milked with relative safety. All minimised discomfort for the snake and maximised safety for the handler.

Tanner figured in the immunological literature as a result of his work with the large elapids. Following many bites, he had become highly allergic to CSL antivenom. For this reason, Dr Saul Wienerr undertook active immunisation of Tanner with Tiger Snake (*Notechis scutatus*) venom in 1959. Weiner (1960) successfully immunised Charles Tanner through 24 injections of Tiger Snake venom over 13 months. This protection was transitory. Thereafter, Tanner rightly became apprehensive about antivenom therapy.

All elapids intrigued Tanner, but Taipans, *Oxyuranus* spp., intrigued him most. Perhaps his greatest excitement and contribution was catching the first live specimen ever seen by researchers of the snake now known as the Western Taipan, *Oxyuranus microlepidotus* (McCoy, 1879). Soon after his close association with the Museum of Victoria began, he read the description (1879) of *Diemenia microlepidata* and examined the two type specimens of this species in the (then) National Museum of Victoria. Many years later, following receipt of a preserved head/tail of this species at the Queensland Museum, he and one of us (JAC) relocated this long-lost species in south western Queensland. Charles Tanner caught his and the world's first live specimen in spring, 1974, near Windorah, SWQ. In one week he collected 13 large, healthy specimens which formed the nucleus of a collection on which an extensive research programme was based. From study of those specimens and their progeny, a series of papers was published on *O.microlepidotus*. Over some 20 years, the least well-known elapid species in Australia became probably its best known (Covacevich & Wombey, 1976; Sutherland et al, 1978; Covacevich et al., 1981; Shine & Covacevich, 1983; Cavacevich & Tanner, 1983; Broad et al., 1979b; Morrison et al., 1984; Covacevich, 1987; Covacevich, 1990; Covacevich, 1994.

In the Australian Venom Research Unit, Department of Pharmacology, the University of Melbourne, a study to examine the antibodies to snake venom components and antibodies to snake venom components and antivenoms in the sera of herpetologists is underway. Charles Tanner had a particular interest in this project. He had not only two types of antibodies to eight different venom proteins, but also antibodies to

the principle protein in antivenom. Thus, as his and the other sera continue to be explored, his contributions to medical research will continue!

Two species have been named to recognise his many contributions to herpetology: *Pseudonaja affinis tanneri* (Worrell, 1961), *Lygisaurus tanneri* Ingram & Covacevich, 1988.

In addition to his many contributions to toxinology and herpetological taxonomy, Charles Tanner will be remembered for his wisdom and for the generous way he shared his knowledge with both amateur and professional herpetologists. He will also be remembered for his dry sense of humour. Nothing encapsulates his wit and humour so well as a conversation he had with one of us (JAC) in 1993. It went: JAC: "Charles, how are you? CT: Fine thanks, except that my memory, especially my short-term memory, is shot to pieces. JAC: Hell. I'm sorry. That must be difficult for you. CT: It would be, if I could remember anything to worry about". The words on a memorial erected to his memory on his former farm near Cooktown summarise: "Passionate about the natural world (especially reptiles!), he contributed significantly in the fields of taxonomy and toxinology, and to knowledge of the natural history of turtles, crocodiles and elapid snakes. Adventurous, generous of spirit, witty, intelligent, and ruggedly individualistic, he was admired and respected by many. Remembered well by his friends and colleagues.

Alis volat propriis

(He flies on his own wings)."

LITERATURE CITED

Broad, A.J., Sutherland, S.K. & Coulter, A.R. 1979a. The lethality in mice of the dangerous Australian snake venoms and certain exotic snake venoms. Toxican 17: 661-4.

Broad, A.J., Sutherland, S.K., Tanner, C. & Covacevich, J. 1979b. Electrophoretic, enzyme and preliminary toxicity studies of the venom of the Small-scaled Snake, *Parademansia microlepidota* (Serpentes: Elapidae), with additional data on its distribution. Memoirs of the Queensland Museum 19(3): 319-329 pls 1,2.

Covacevich, J., 1987. Two Taipans! in Covacevich, J., Davie, P. & Pearn, J. (eds). Toxic Plants and Animals: A Guide for Australia. (Queensland Museum: Brisbane).

Covacevich, J., 1990. Phangs and Physic: 40,000 years of Risky Business in Pearn, J. & Cobcroft, M. (eds). Fevers and Frontiers. (Amphion Press: Brisbane).

Covacevich, J., 1994. Dandarabilla and Gunjiwuru. The discovery of the Taipans - the worldís most dangerous snakes in Pearn, J.H. (ed). Milestones of Australian Medicine. (Amphion Press: Brisbane).

Covacevich, J. & Tanner, C., 1983. Come from nowhere ... then just disappear. Australian Natural History 21(1):11-13.

Covacevich, J. & Wombey, J., 1976. Recognition of Parademansia microlepidotus (McCoy), Elapidae, a dangerous Australian snake. Proceedings of the Royal Society of Queensland 87: 29-32, pls. 1-2.

Covacevich, J., McDowell, S.B., Tanner, C. & Mengden, G.A., 1981. The relationship of the Taipan, Oxyuranus scutellatus, and the Small-scaled Snake, Oxyuranus microlepidotus in Banks, C.B. and Martin, A.A. (eds). Proceedings of the Melbourne Herpetological Symposium 1980. pp. 160-8. (The Melbourne Zoological Board: Parkville).

Covacevich, J., Pearn, J. & White, J., 1988. The worldís most venomous snake in Pearn, J. and Covacevich, J. (eds). Venoms and Victims. (Amphion Press and Queensland Museum: Brisbane).

Morrison, J., Pearn, J., Covacevich, J., Tanner, C. & Coulter, A., 1984. Studies of the venom of Oxyuranus micrlepidotus. Clinical Toxicology 21(3): 373-385.

Pearn, J.H., 1990. Herpetologists and snakebite. Memoirs of the Queensland Museum 29(2): 406.

Pearn, J.H., Covacevich, J., Charles, N. & Richardson, P., 1994. Snakebite in herpetologists. Medical Journal of Australia 161(5/19 December, 1994): 706-708.

Shine, R. & Covacevich, J., 1983. Ecology of highly venomous snakes: the Australian genus Oxyuranus (Elapidae). Journal of Herpetology 17(1):60-69.

Sutherland, S.K., Broad, A.J., Tanner, C. & Covacevich, J., 1978. The Small-scaled or Fierce Snake (Parademansia microlepidotus) - its recognition as Australiaís potentially most venomous snake. Medical Journal of Australia 1:288-9.

Wiener, S., 1960. Active immunization of man against the venom of the Australian Tiger Snake (Notechis scutatus). American Journal of Tropical Medicine and Hygiene. 9: 284-92.

Worrell, E., 1963. Reptiles of Australia. (Angus & Robertson, Sydney). 207pp.

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BOOK REVIEW

TURTLES OF THE UNITED STATES AND CANADA

by C.H. Ernst, J.E. Lovich, and R.W. Barbour

Published by the Smithsonian Institution, Washington DC, USA

To properly review a book like this one, one must consider what the objectives of the book are, or what the authors intended to achieve through its publication. To paraphrase the preface, the book attempts to *summarise the knowledge of the life histories of North American turtles*. After perusing the book, one quickly realises that the authors accomplished their intention.

The focus is, of course, on North American turtles, and the book is divided into three basic sections: introduction, identification, and species accounts. The introduction is informative and readable, and includes the evolutionary history of turtles, their distribution in North America, synopses on reproduction, growth, morphology, etc., and finally a nice summary on conservation of North American turtles. The identification section is basically a key to North American turtles, and the users will find the key relatively easy to use, as North American turtles are generally easily identifiable to species, relative to turtles elsewhere (e.g. Australian chelids are extremely difficult to distinguish, relative to North American emydids).

The meat of the book is the species accounts, which are preceded by a summary on each family, its number of North American genera and species, and some homologous features of the family. The species accounts are divided into 14 sections: recognition, karyotype, fossil record, distribution, geographic variation, confusing species, habitat, behaviour, reproduction, growth and longevity, food habits, predators and defence, populations, and remarks. Partitioning the information in this way is critical, because the authors include a wealth of information gleaned from the literature in most sections. Thus, for example, the referencing behaviourist can ignore the section on distribution (though he or she should not). For identification, a distribution map and several excellent black and white photographs accompany each species account, and a set of beautiful colour plates (basically, one for each of 57 species included in the book) in the middle of the book is probably sufficient in itself to identify most species of North American turtles. A

glossary of scientific names is an excellent addition to the book, and I was pleased to see the derivations of those names included - etymology seems to be largely ignored among young herpetologists today.

The only structural criticism I have is that the authors should have arranged the species accounts alphabetically by family, genus, and species for ease in referencing. Elsewhere, cladograms in the reptile evolution and turtle evolution and systematics sections would have helped the reader to understand more clearly those relationships. As for coverage, Jackson (1995), in a review of the book, calls for the inclusion of central American turtles in the next edition, but only the kinosternids (mud and musk turtles, incidentally a favourite of Jackson's) suffer from the exclusion of Mexico and central America in the current edition.

I closely examined seven arbitrarily chosen species accounts, of which five were flawless as I saw them, one had two minor editorial mistakes, and one had the following relatively minor errors. The authors state the *Graptemys ouachitensis* is a medium-sized to large map turtle, when, in fact *G.ouachitensis sabinensis* is probably the smallest of map turtles. Concordant with body size, mean clutch size of *G.o.sabinensis* is also very small (N=2), which does not fall within the range indicated by the authors (6-15 eggs/clutch). On the positive side, the authors remind us that "so little is known of the ecology and behaviour of the species (*G.ouachitensis*) in the southern portion of its range, that an extensive study of its life history is needed." Such recommendations are invaluable as they may provide direction for further study.

The book is the most comprehensive compilation on North American turtles ever attempted and achieved, and would be the first and foremost reference on the shelf of any person interested in North American turtles. For the turtle biologist, it is also a welcome collection of information and references. The authors have filled the text with citations, taking the book above the level of a field guide or identification book, and providing turtle enthusiasts with what they need in order to understand and love one of most fascinating of all creatures. It seems the authors considered no reference too small, and the only 'missing' citations I could find were very recent ones, undoubtedly not included due to the need for a stopping point in the preparation and publishing process.

From an international point of view, the Australian reader may well have liked to see more substantial sections in the book that integrate knowledge across species (i.e. what aspects of the biology of emydids are ubiquitous, or how are North American emydids different from old worlds emydids?) in addition to species by species accounts. This would have given the book a greater international appeal, but was not the primary focus of the book, and should not be considered a major criticism, but perhaps a suggestion for a future book. To the Australian turtle biologist, the book is essential for understanding the true diversity of turtles of the world, as five families of turtles occur in North America that are not found in Australia.

In summary the book is easily worth the cost (A$80), even to the impoverished graduate student. Jackson (1995) found minor errors in the text, and I agree with him that there should be distribution maps for the sea turtles. However, I find it pointless to peruse the entire book for minor errors when such errors are inescapable. Anyone interested in North American turtles must obtain this book, and a turtle biologist's bookshelf without it would be like a refrigerator without milk.

LITERATURE CITED

Jackson, D.R. (1995). Book review: Turtles of the United States and Canada. Ernst, C.H., J.E. Lovich and R.W. Barbour (eds.). Copeia 1995: 998-999.

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NOTES TO CONTRIBUTORS

Herpetofauna publishes articles on any aspect of reptiles and amphibians. Articles are invited from interested authors particularly non-professional herpetologists and keepers. Priority is given to articles reporting field work, observations in the field and captive husbandry and breeding.

All material must be original and must not have been published elsewhere.

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Authors are responsible for the accuracy of the information presented in any submitted article. Current taxonomic combinations should be used unless the article is itself of a taxonomic nature proposing new combinations or describing new species.

Original illustrations will be returned to the author, if requested, after publication.

SUBMISSION OF MANUSCRIPT

Two copies of the article (including any illustrations) should be submitted. Typewrite or handwrite (neatly) your manuscript in double spacing with a 25mm free margin all round on A4 size paper. Number the pages. Number the illustrations as Figure 1 etc., Table 1 etc., or Map 1 etc., and include a caption with each one. Either underline or italicise scientific names. Use each scientific name in full the first time, (eg *Delma australis*), subsequently it can be shortened (*D. australis*). Include a common name for each species.

The metric system should be used for measurements.

Place the authors name and address under the title.

Latitude and longitude of any localities mentioned should be indicated.

Use the Concise Oxford Dictionary for spelling checks.

Photographs – black and white prints are preferred but colour slides are acceptable.

Use a recent issue of *Herpetofauna* as a style guide.

A computer disc may be submitted instead of hard copy but this should not be done until after the manuscript has been reviewed and the referees' comments incorporated. Computer discs must be HD 1.44 mb 3.5" in Word for Windows; Wordperfect; Macintosh or ASCI. Any disc must also be accompanied by hard copy.

Articles should not exceed 12 typed double spaced pages in length, including any illustrations.

REFERENCES

Any references made to other published material must be cited in the text, giving the author, year of publication and the page numbers if necessary. At the end of the article a full reference list should be given in alphabetical order. (See this journal).

Manuscripts will be reviewed by up to three referees and acceptance will be decided by an editorial committee. Minor changes suggested by the referees will be incorporated into the article and proofs sent to the senior author for approval.

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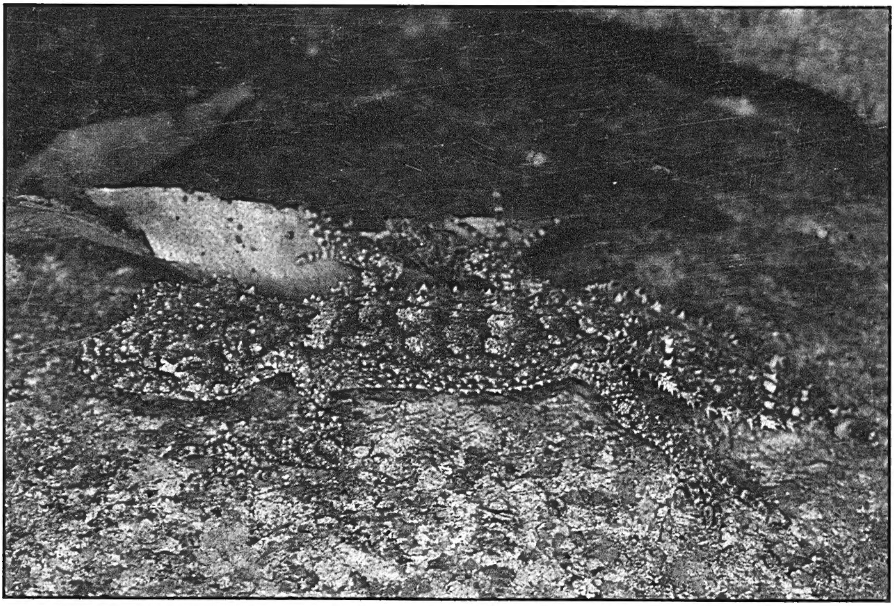

A Juvenile Leaf-tailed gecko *(Saltuarius swaini)* from Giraween National Park. See paper on page 51. (photo: R. Porter).

Gillens Pygmy monitor *(Varanus gilleni)* from Kulgera N.T. See paper on page 2. (photo: P. Rankin).